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These hoists will raise a load of two tons to a height of one foot with a pull of 125 lbs. while overhauling only 39½ feet of hand chain.

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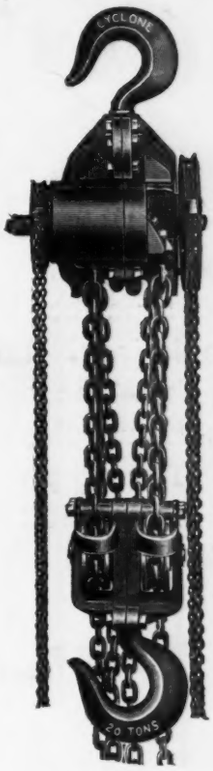

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THE FOUNDRY

Vol. 33, No. 2 CLEVELAND, OHIO, OCTOBER, 1908 Whole No. 194

MOLDING MACHINES FOR LARGE WORK

Use of jarring machines at the plant of the Filer & Stowell Co., for molding engine and woodworking machinery castings

THE TENDENCY of recent development in molding machine practice is toward the use of larger and heavier tools for molding many of the patterns now made on the floor. Several machines have been built for making molds weighing 10,000 pounds, and the limit has not yet been reached. The use of machines for small work has effected untold economies, but on large floor work the saving of labor is proportionately greater, and machines are being designed and built for making truck and body bolsters, ingot molds, locomotive and stationary engine cylinders, engine frames, etc.

Battery of Jarring Machines.

The Filer & Stowell Co., Milwaukee, manufacturer of engines and woodworking machinery, has successfully mounted many of its large patterns on machines, and the output has thereby been increased from 300 to 400 per cent, while the number of men employed on the various jobs has been greatly reduced. Floor jobs that are now machine molded in the foundry of this concern include large cylinders, elbows, cylinder heads, pipe fittings, etc. While a large number of machines are operated in this shop, the large work is made on jarring machines built by the Herman Pneumatic Machine Co., Zelienople, Pa. The table plates of two of these machines are 36 x 50 inches, while the other two can take in flasks 24 x 30 inches and 35 x 38 inches, respectively. The lifting capacity of the cylinders of the large machines is

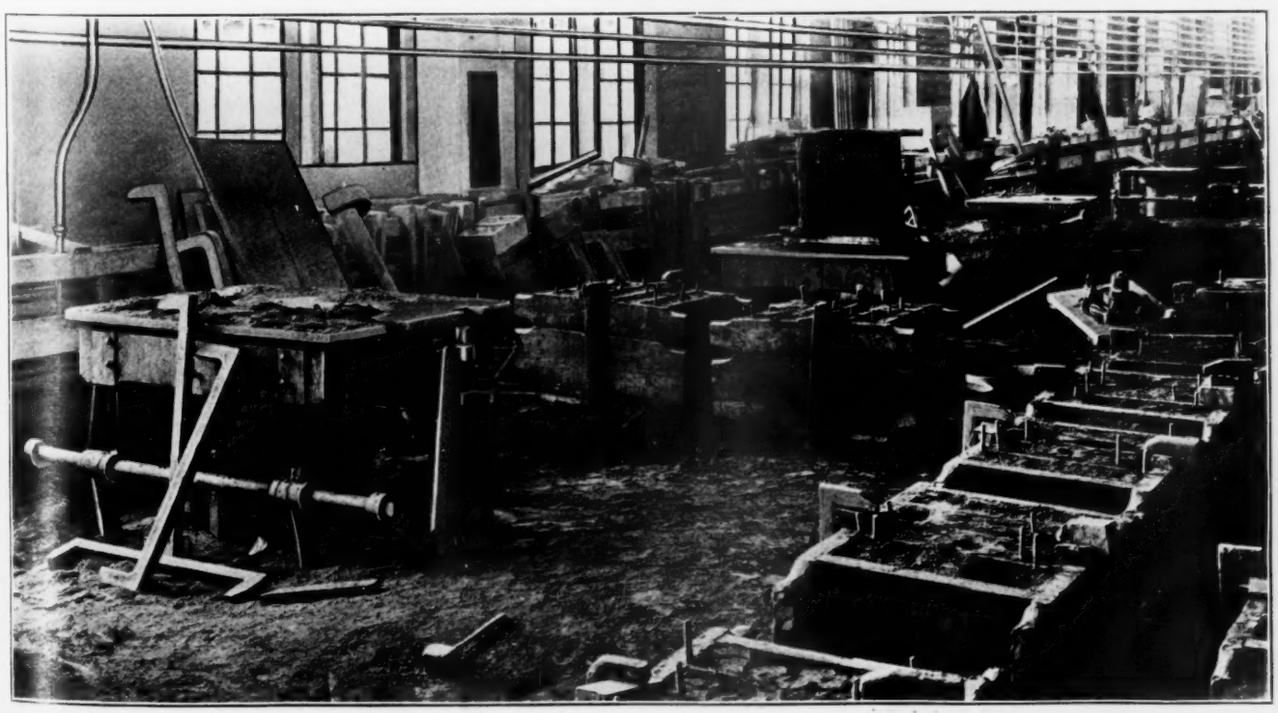

FIG. 1—BATTERY OF FOUR JARRING MOLDING MACHINES IN THE FOUNDRY OF THE FILER & STOWELL CO., MILWAUKEE

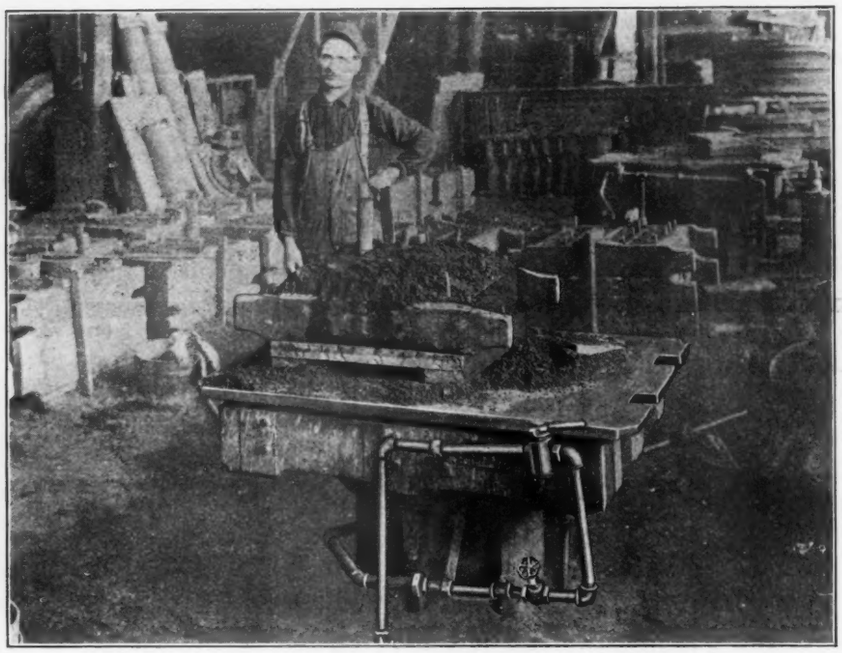

FIG. 2—COPE HALF OF PISTON MOLD READY FOR JAR RAMMING

2,500 pounds at 60 pounds air pressure, and 3,200 pounds at 80 pounds air pressure, while the smaller machines can handle flasks weighing from 800 to 2,900 pounds. In Fig. 1 is shown this battery of machines, which is operated by handymen.

Piston Head Mold.

In Fig. 2 is shown the cope half of a piston head mold finished up to the point of jarring. It will be seen that the sand is heaped well above the flask and that none of the gaggers are visible. Up to this point the molding operation is similar to hand work on the floor. Sand is first riddled over the pattern, the gaggers are set and the sand is packed under the cross pieces of the flask by hand. The balance of the sand is then shoveled in freely and heaped as shown. The same mold is shown in Fig. 3 after the jarring operation. This lasted about 30 seconds. The packing of the sand and the extent to which its volume was reduced is shown by the projecting tops of the gaggers. It will also be seen that very little sand was shaken from the flask on to the table.

The mold and pattern of the cope of a piston head, the molding operations of which were shown in Figs. 2 and 3, is illustrated in Fig. 4. It will be noted that the pattern is mounted on a board. Operating steadily both cope and drag halves of this piston head mold can be completed in from 10 to 12 minutes. The cope requires more attention than the drag because of the extra tamping by hand and the setting of gaggers. When making the drag half of the mold, the sand is merely shoveled into the flask and ramming is completed by the jarring operation. No vent wires are used on these molds, nor are any considered necessary when the molds are jarred in this way.

Large Cylinder Mold.

The cope and drag of an 11-inch cylinder, which weighs 550 pounds finished, is shown in Fig. 5. The mold with the cores in place is shown at the top of the illustration, Fig. 6. These molds are made on the largest machine used by this concern and one operator can produce from 6 to 8 daily. Heretofore one molder produced two on the floor and this was considered a big day's work. The pattern and drag half mold of a top cylinder head of a 12-inch x 20-inch twin Filer & Stowell engine are shown in Fig. 6. These molds are made on jarring machines and require practically no retouching after they have been removed to the floor.

Suction Pipe Mold.

The drag flask for a 6-inch suction pipe mold, 4 feet long, is shown in Fig. 6. The table of the machine on which the flask is mounted is 50 x 56 inches and the flask is somewhat larger than the platen. A sand frame is placed on top of the flask to carry the extra sand required after it has become packed around the pattern in the flask. In Fig. 8 the same mold is shown after jarring with the sand frame removed, and it will be seen to what extent the sand has been packed by the jarring operation.

Sand Frame.

In this instance, the height of the sand has been reduced about 4 inches, uniformly over the area of the flask. Three men are employed in producing this mold, all of them handymen about the shop. The mold was made complete in six minutes, including the placing of the pattern and flasks on the machine, the shoveling of the sand

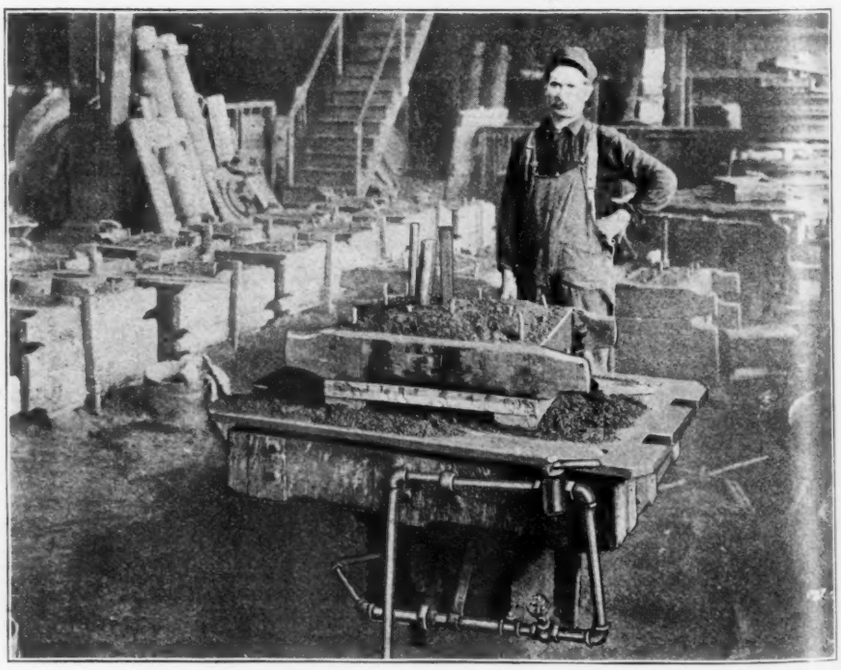

FIG. 3—PISTON MOLD AFTER THE JARRING OPERATION

into the flask, the jarring, and the lifting off of the flask on to the floor. The drag mold completed is shown in Fig. 9. This mold does not require venting, as the ramming is so uniform that it permits of a uniform diffusion of the gases. As compared with castings made on the floor, the machine made product required less cleaning, there is almost an entire absence of fins, and the castings, with few exceptions, are all of a uniform thickness. Furthermore, the records show that there is a considerable saving in the amount of iron required in the foundry.

Roll-Over and Pattern Drawing Arrangement.

While the machines shown in the accompanying illustrations are only used for ramming the molds and the flasks are lifted off either by hand or overhead cranes, two lifting cylinders are provided for each, which have a two-fold action. The mold can either be lifted away from the pattern, or the mold and pattern can be raised from the table of the machine, then rolled over in the trunnions at the head of the lifting pistons, and the patterns drawn upward from the mold as by the ordinary method of hand molding. Stripping plates can likewise be used to advantage on these jarring machines.

The Dundee Brass Mfg. Co., Dundee, N. Y., is having plans prepared for a one-story foundry, 40 x 200 feet. The building will be of concrete construction.

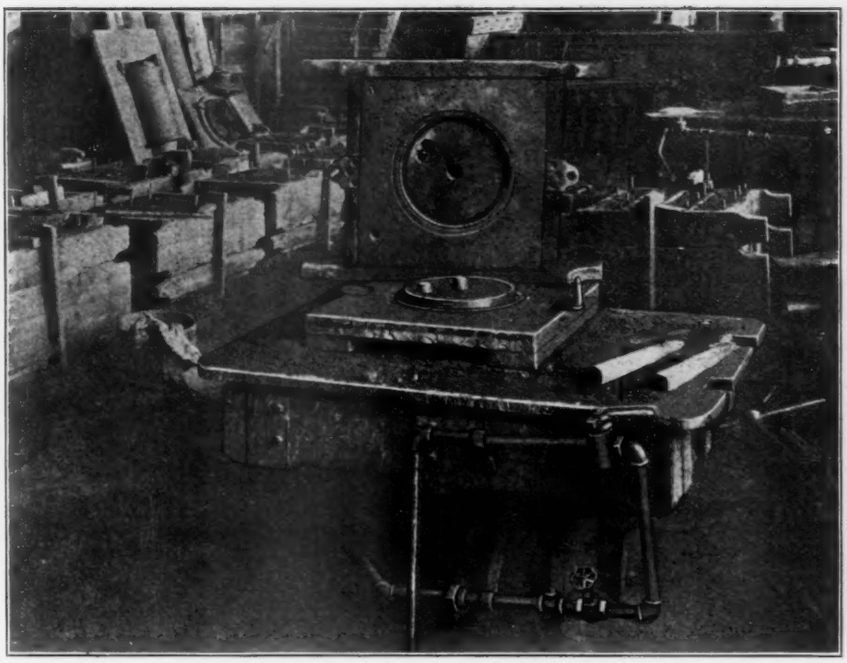

FIG. 4—MOLD AND PATTERN OF THE COPE HALF OF A PISTON HEAD

POROUS BRASS CASTING.

Question:—I am having considerable trouble in obtaining sound castings for large connecting rod ends. The castings are porous. Will you kindly advise us what causes this difficulty?

Answer:—My experience with such troubles has taught me, that they generally originate in the furnace through unskilled or careless melting. Porous castings can be very easily produced at the will of the melter, all that is necessary being to charge the crucible with brass or copper, which is allowed to wilt and melt down, and become hot, before other metal is charged, the process being repeated until the pot is filled.

Melted under such conditions, brass has every opportunity to oxidize and absorb gases, which are held in suspension in the liquid metal and are carried into the mold, becoming a part of the casting, and, being squeezed from the center to the circumference of the same by the pressure of solidification, lodge beneath the skin, causing the porous or sponge-like appearance.

The reason this sponginess does not appear on the face of the casting, is because when it is poured, the metal that comes in contact with the cold walls of the mold is chilled, forming a skin of solid metal through which the gases cannot penetrate.

The casting, therefore, appears normal, and more or less machine work is done upon it before its defects become visible. It will be seen, therefore, how important an operation is the melting of brass and copper.

In my opinion it is the most important part of the operation of a brass foundry. To prevent porosity is just as simple a matter as to cause it. It must be carried in mind that the enemies of the founder which rob him of his profits are oxygen and the various products of combustion, which produce changes in the metal, and from which it must be protected when in a heated condition. Therefore, when melted, its surface must be at all times covered, and one of the best materials for this purpose is glass. A small quantity should be placed in the bottom of the crucible before charging.

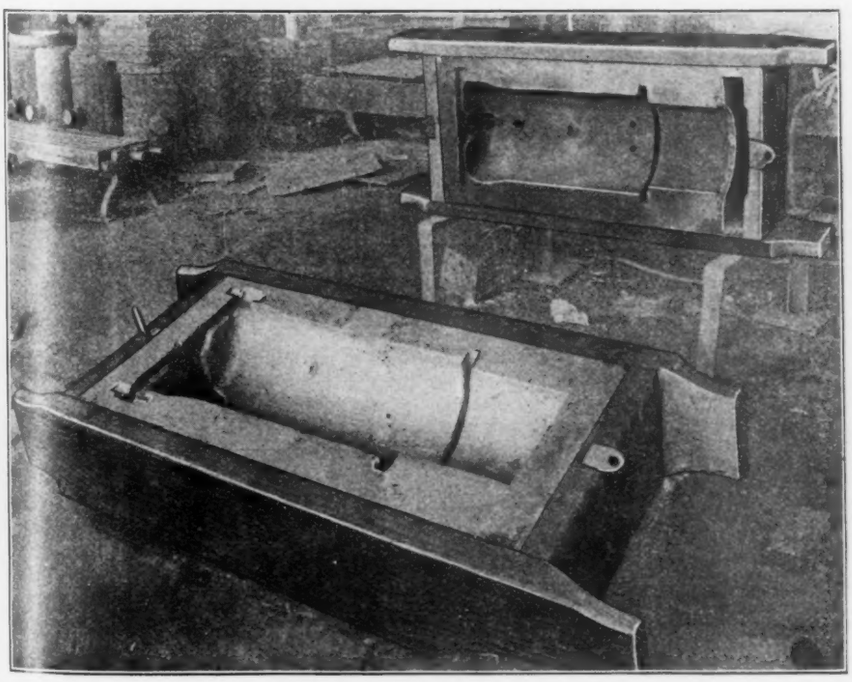

FIG. 5—COPE AND DRAG OF AN 11-INCH CYLINDER MADE ON A JARRING MACHINE

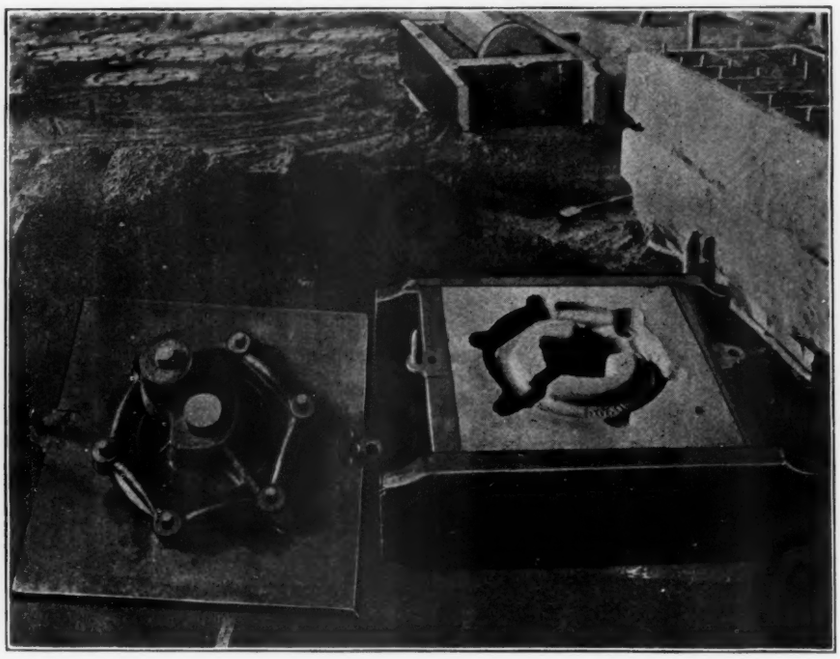

FIG. 6—PATTERN AND DRAG MOLD OF A LARGE CYLINDER HEAD

This melts and forms a slag which floats on the metal, covering the same.

The greatest damage, however, is done during the progress of the melt, when the pot is filling up. When charged with pieces of brass, this brass is exposed to the atmosphere, and as it becomes hot, is oxidized and if allowed to melt without attention, it preserves its form for a long time after it is melted and the center has run out.

This form is but the ghost of the original piece of brass, it is the oxidized shell, a slight touch of the stirring iron and it vanishes and is dissolved in the melted metal.

Look out for these ghosts, for they steal your profits. The preventives are energy and charcoal. Energy is necessary because the metal must be poked down when sufficiently heated, pushed under the protecting cover of glass.

Charcoal is a most energetic reducing agent and should never be dispensed with when melting copper or its alloys. Waste pieces of wood, tanbark, sawdust, or anything that will burn to charcoal can be used in its place, and something of the kind is absolutely necessary in melting brass.

Another good thing is common salt, but care should be exercised in its use, not that it is possible to injure the metal by using too much, but because its fumes are so acrid and irritating and so persistent, that if too much is used, these fumes are given off when pouring the metal, causing much discomfort and suffering to the men who are obliged to inhale them. Therefore, use the salt in moderation, say one ounce to the pot of metal, and if found too much decrease it, and if there are no fumes when pouring, try a little more the next heat. You will thus find out the exact quantity to use with each heat, the idea being for the salt fumes to be given off during process of melting, creating a neutral atmosphere about the heated metal, the fumes being exhausted by the time the metal is ready for removal from the furnace.

To sum up, use charcoal, salt and glass and see the metal receives proper attention when melting. The sample of brass submitted is of poor quality; it runs high in lead, and contains iron. The addition of four ounces manganese-copper to 100 pounds of metal would improve it, and above all do not pour too hot. K. K.

MALLEABLE CASTINGS IMPERFECTLY ANNEALED.

BY RICHARD MOLDENKE

A correspondent has sent us a casting which shows up a fair anneal on one side and nearly white (annealed) on the other. The structure appears very open, even if the annealing seems to have been accomplished all right on one side. The composition not being given, the fracture indicates a fairly high silicon for a casting which is 1-inch thick. The metal would have done better for light work. The consequence of such a structure is that, when annealed, the oxidizing influence, instead of being confined to the skin, penetrates sufficiently to weaken the entire piece, though not enough to make it appear white if broken very slowly and giving the crystals a chance to tear apart in a natural way. However, if the piece is given a sharp blow it will break and will show a bright gray fracture and will have the appearance of being improperly annealed. As a matter of fact it is over-annealed in a way, inasmuch as less time in the anneal might have resulted in a better casting.

Very often a foundry will have a long run of this kind of work and it

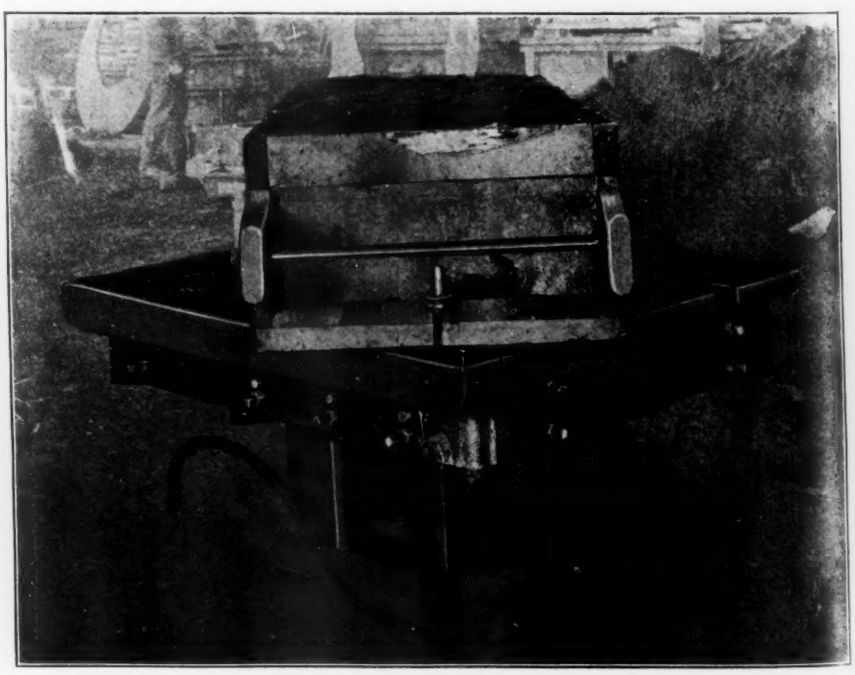

FIG. 7—LARGE FLASK WITH SAND FRAME IN POSITION BEFORE RAMMING

is very trying. The test plugs will break short without any great bending effect, and the inspector will be puzzled whether to let the section pass or to reject it. The iron is not up to the standard in strength and the proper remedy for the same is a problem. My own experience has always brought it home to the melting. The heats may be kept in too long from furnace difficulties or from inattention on the part of the melter to his business. It is advisable to time the heats to see if they are running longer than normal. Unless the melter uses his muscle and gets his bath liquid very quickly, the agglomeration of pigs form a sticky mass which cannot be worked piece by piece into the bath, but will have to melt down as a whole and as a result at least one-half hour will be added to the heat. This increases the chance for oxidation and results in the weakening of the iron, which, in turn, is accentuated in the anneal.

In this instance I would say that no malleable casting 1-inch thick can be cast successfully from every standpoint without the addition of considerable steel to the bath or the reduction of the silicon to a very low point, or the application of chills. Otherwise it will surely be open in structure and weak. It is necessary to get the iron in the hard so close that annealing will not injure it. As a matter of fact there is a tendency at all times to run the silicon too high on account of the fact that getting the lower ranges introduces another element of danger. Still the lower ranges always give stronger castings. I have invariably found that iron similar to the sample in question is always produced where the tactics of the steel melter are allowed to prevail in the malleable foundry. The malleable heat should be vigorous, short, intensely hot and there should be chance for as little chemical action, or refining, as possible. The reduction of carbon aimed at by refining can far better be brought about by the addition of steel scrap and the danger of oxidation by long heats can thereby be avoided.

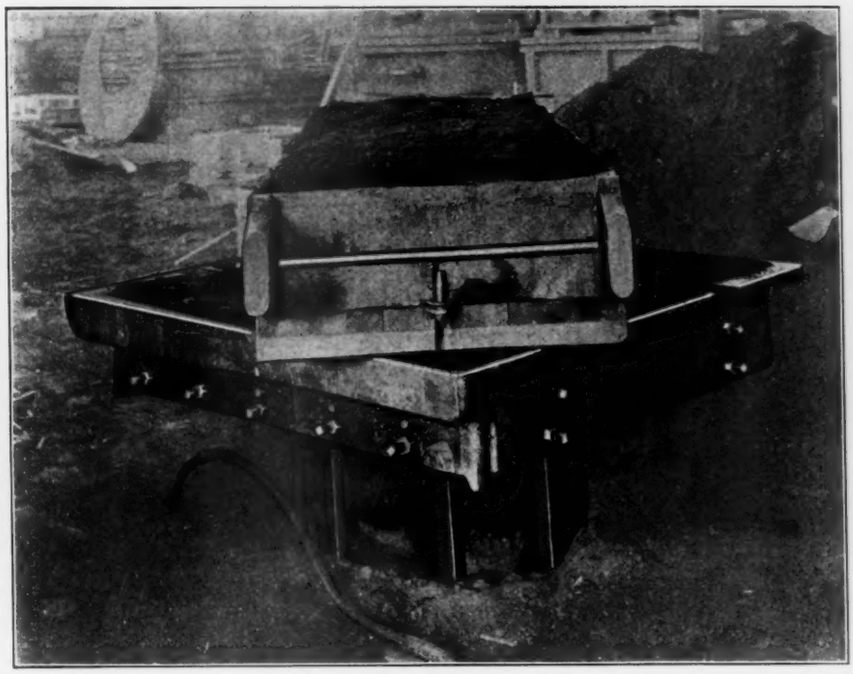

FIG. 8—MOLD SHOWN IN FIG. 7 AFTER JARRING. THE SAND FRAME HAS BEEN REMOVED

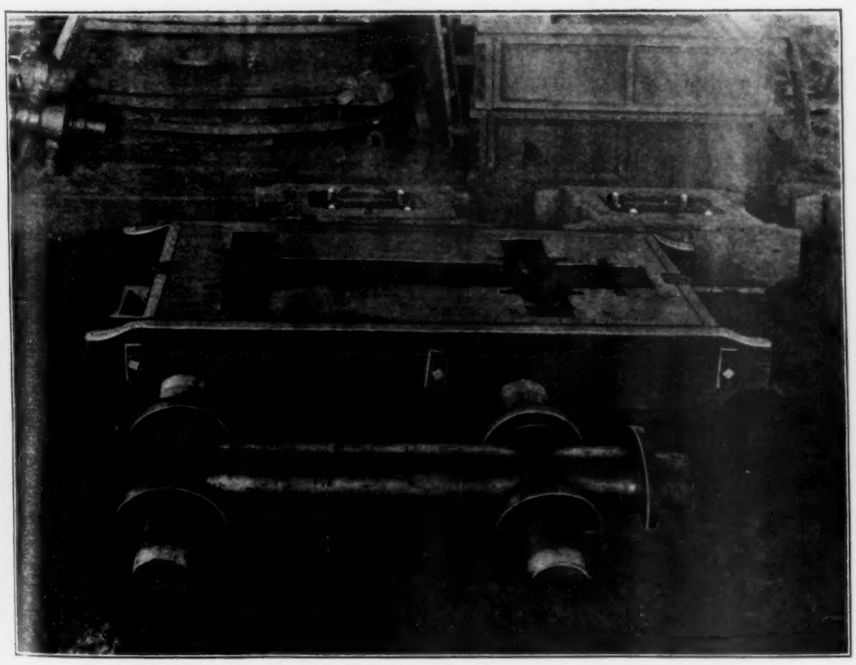

FIG. 9—SUCTION PIPE MOLD MADE ON A JARRING MOLDING MACHINE

TRIGONOMETRIC SLIDE RULE.

M. J. Eichhorn, electrical engineer, 5759 Aberdeen street, Chicago, has devised a trigonometric slide rule which is not intended to supplant the well known forms of the Mannheim rules, but is, on the contrary, intended to supplement them. The saving in time as compared with the present methods which can be effected with the new rule is one of its most important features, and this is accomplished by the introduction of novel graduations, which embody the required calculations, and thereby relieve the user from remembering or looking up cumbersome formulae and tables, while permitting a direct reading of the result.

DUTY ON MALLEABLE CASTINGS.

The board of United States general appraisers held, in protests of W. A. Fleetham, Detroit, that malleable castings were dutiable at 0.9 cent per pound under paragraph 149 of the tariff and not at 45 per cent, the rate assessed, under paragraph 193. The board found from examination of the official samples that the articles were iron castings upon which no labor nor manufacture had been bestowed subsequent to the casting process.

DIAMETER OF LADLE AT THE BOTTOM IN INCHES.

Steel in ladle inches.	20	20½	21	21½	22	22½	23	23½	24	24½	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
1	85	89	93	98	102	107	112	117	122	127	132	143	154	166	178	190	203	216	230	244	259	274	289	305	321	338	355	372	390	409	427
2	171	179	188	197	206	215	225	235	245	255	266	287	310	333	357	382	408	434	462	490	519	549	580	612	644	678	712	747	783	820	857
3	257	270	283	297	311	325	339	354	369	385	401	433	467	502	538	575	614	654	695	738	782	827	873	921	970	1,020	1,071	1,124	1,178	1,233	1,289
4	345	363	380	398	417	436	455	475	495	516	537	580	625	672	720	770	822	875	931	988	1,046	1,106	1,168	1,232	1,297	1,364	1,432	1,503	1,575	1,648	1,724
5	434	456	478	501	524	548	572	597	622	648	674	729	785	843	904	967	1,032	1,099	1,168	1,239	1,312	1,388	1,465	1,545	1,626	1,710	1,796	1,884	1,974	2,066	2,161
6	524	550	577	604	632	661	690	720	750	781	813	878	946	1,016	1,090	1,165	1,243	1,324	1,407	1,492	1,580	1,671	1,764	1,860	1,958	2,059	2,162	2,268	2,376	2,487	2,600
7	615	646	677	709	742	775	809	844	880	916	953	1,030	1,109	1,191	1,277	1,365	1,456	1,550	1,647	1,747	1,850	1,956	2,065	2,177	2,291	2,409	2,530	2,563	2,780	2,909	3,042
8	708	743	778	815	852	891	930	970	1,011	1,052	1,095	1,182	1,273	1,368	1,465	1,566	1,671	1,778	1,890	2,004	2,122	2,243	2,368	2,496	2,627	2,762	2,900	3,041	3,186	3,334	3,486
9	801	840	881	922	964	1,008	1,052	1,097	1,143	1,190	1,238	1,336	1,439	1,545	1,655	1,769	1,887	2,008	2,134	2,263	2,396	2,532	2,673	2,817	2,965	3,117	3,272	3,432	3,595	3,762	3,932
10	895	939	984	1,030	1,077	1,126	1,175	1,225	1,276	1,329	1,382	1,492	1,606	1,725	1,847	1,974	2,105	2,240	2,380	2,523	2,671	2,823	2,980	3,140	3,305	3,474	3,647	3,824	4,006	4,191	4,381
11	991	1,039	1,089	1,140	1,192	1,245	1,299	1,354	1,411	1,469	1,528	1,649	1,775	1,906	2,040	2,180	2,325	2,474	2,628	2,786	2,949	3,116	3,288	3,465	3,647	3,833	4,024	4,219	4,419	4,623	4,833
12	1,088	1,141	1,195	1,250	1,307	1,365	1,425	1,485	1,547	1,610	1,675	1,807	1,945	2,088	2,235	2,388	2,546	2,709	2,877	3,050	3,228	3,411	3,599	3,792	3,991	4,194	4,403	4,616	4,834	5,058	5,287
13	1,185	1,243	1,302	1,362	1,424	1,487	1,552	1,617	1,685	1,753	1,823	1,967	2,116	2,271	2,432	2,598	2,769	2,946	3,128	3,316	3,509	3,708	3,912	4,122	4,337	4,558	4,784	5,015	5,252	5,495	5,743
14	1,284	1,346	1,410	1,475	1,542	1,610	1,680	1,751	1,823	1,897	1,973	2,128	2,290	2,457	2,630	2,809	2,994	3,185	3,381	3,584	3,792	4,007	4,227	4,453	4,685	4,923	5,167	5,417	5,672	5,934	6,201
15	1,384	1,451	1,519	1,590	1,661	1,734	1,809	1,885	1,963	2,043	2,124	2,291	2,464	2,644	2,830	3,022	3,220	3,425	3,636	3,854	4,077	4,308	4,544	4,787	5,036	5,291	5,553	5,821	6,095	6,376	6,663
16	1,485	1,557	1,630	1,705	1,782	1,860	1,940	2,021	2,105	2,190	2,277	2,455	2,460	2,832	3,031	3,236	3,448	3,667	3,893	4,125	4,365	4,610	4,863	5,122	5,388	5,661	5,940	6,227	6,520	6,819	7,126
17	1,587	1,664	1,742	1,822	1,903	1,987	2,072	2,159	2,248	2,338	2,430	2,620	2,818	3,022	3,234	3,452	3,678	3,911	4,152	4,399	4,653	4,915	5,184	5,468	5,743	6,033	6,331	6,635	6,947	7,266	7,592
18	1,691	1,772	1,855	1,939	2,026	2,115	2,205	2,297	2,392	2,487	2,586	2,788	2,997	3,214	3,438	3,670	3,910	4,157	4,412	4,674	4,944	5,222	5,507	5,800	6,100	6,407	6,723	7,046	7,377	7,715	8,060
19	1,795	1,881	1,969	2,058	2,150	2,244	2,339	2,437	2,537	2,639	2,742	2,956	3,177	3,407	3,644	3,890	4,143	4,405	4,674	4,952	5,237	5,530	5,831	6,141	6,459	6,784	7,117	7,459	7,808	8.166	8,531
20	1,901	1,991	2,084	2,179	2,276	2,375	2,476	2,579	2,684	2,791	2,901	3,126	3,360	3,602	3,852	4,111	4,378	4,654	4,938	5,231	5,532	5,841	6,159	6,485	6,820	7,163	7,514	7,874	8,243	8,620	9,005
21	2,008	2,103	2,201	2,300	2,402	2,506	2,613	2,721	2,832	2,945	3,060	3,297	3,543	3,798	4,061	4,334	4,615	4,905	5,204	5,512	5,828	6,154	6,488	6,831	7,183	7,544	7,913	8.292	8,679	9,076	9,481
22	2,116	2,216	2,318	2,423	2,530	2,639	2,751	2,865	2,982	3,100	3,221	3,470	3,728	3,996	4,272	4,558	4,853	5,158	5,472	5,795	6,127	6,468	6,819	7,179	7,548	7,927	8,315	8,712	9,118	9,534	9,859
23	2,225	2,330	2,437	2,547	2,659	2,774	2,891	3,011	3,132	3,257	3,384	3,644	3,915	4,195	4,485	4,784	5,094	5,413	5,741	6,080	6,428	6,785	7,153	7,529	7,916	8,312	8,719	9,134	9,559	9,995	10,440
24	2,335	2,445	2,557	2,672	2,790	2,910	3,032	3,157	3,285	3,415	3,547	3,820	4,103	4,396	4,699	5,012	5,336	5,669	6,013	6,366	6,730	7,104	7,488	7,881	8,285	8,700	9,124	9,559	10,003	10,458	10,922
25	2,447	2,561	2,679	2,799	2,922	3,047	3,175	3,305	3,438	3,574	3,713	3,997	4,293	4,599	4,915	5,242	5,579	5,927	6,286	6,655	7,034	7,425	7,825	8,236	8,658	9,090	9,532	9,985	10,450	10,923	11,409
26	.....	.....	2,801	2,927	3,054	3,185	3,318	3,455	3,593	3,735	3,879	4,176	4,484	4,803	5,133	5,473	5,825	6,187	6,561	6,945	7,341	7,747	8,164	8,593	9,032	9,482	9,943	10,415	10,898	11,392	11,897
27	.....	.....	.....	.....	3,189	3,324	3,464	3,605	3,750	3,897	4,047	4,357	4,677	5,009	5,352	5,706	6,072	6,449	6,838	7,238	7,649	8,071	8,506	8,951	9,408	9,876	10,356	10,847	11,349	11,862	12,388
28	.....	.....	.....	.....	.....	.....	3,610	3,757	3,908	4,061	4,217	4,538	4,871	5,216	5,572	5,941	6,321	6,713	7,117	7,532	7,959	8,398	8,849	9,312	9,786	10,273	10,771	11,280	11,802	12,335	12,880
29	.....	.....	.....	.....	.....	.....	.....	.....	4,067	4,226	4,388	4,721	5,067	5,425	5,795	6,177	6,752	6,978	7,397	7,828	8,271	8,728	9,195	9,675	10,167	10,671	11,188	11,717	12,258	12.811	13,376
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,561	4,906	5,265	5,636	6,019	6,415	6,824	7,246	7,680	8,127	8,586	9,058	9,542	10,040	10,550	11,072	11,608	12,155	12,716	13,289	13,874
31	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,093	5,464	5,848	6,245	6,655	7,079	7,515	7,964	8,427	8,903	9,391	9,893	10,407	10,935	11,476	12,030	12.596	13,176	13,770	14,375
32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.664	6,062	6,473	6,897	7,335	7,786	8,251	8,729	9,221	9,726	10,245	10,776	11,323	11,881	12,454	13,040	13,639	14,252	14,878
33	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,277	6,702	7,140	7,593	8,059	8,539	9,033	9,541	10,063	10,598	11,148	11,712	12,289	12,880	13,486	14,105	14,738	15,385
34	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,933	7,385	7,852	8,334	8,829	9,339	9,863	10,402	10,955	11,522	12,103	12,699	13,310	13,934	14,573	15,225	15,893
35	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7,632	8,114	8,610	9,121	9,647	10,187	10,743	11,313	11,898	12,497	13,111	13,741	14,384	15,042	15,716	16,403
36	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7,881	8,377	8,889	9,415	9,957	10,514	11,086	11,674	12,276	12,893	13,526	14,174	14,837	15,516	16,208	16,917
37	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8,642	9,169	9,711	10,269	10,843	11,431	12,036	12,656	13,292	13,943	14,610	15,292	15,991	16,704	17,433
38	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9,451	10,009	10,583	11,173	11,779	12,401	13,038	13,692	14,362	15,048	15,750	16,467	17,201	17,951
39	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10,309	10,899	11,505	12,128	12,767	13,423	14,095	14,784	15,489	16,210	16,948	17,702	18,472
40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11,216	11,840	12,480	13,136	13,809	14,501	15,207	15,932	16,673	17,431	18,204	18,996
41	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12,177	12,833	13,507	14,199	14,907	15,633	16,376	17,138	17,915	18,710	19,522
42	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13,188	13,880	14,590	15,317	16,062	16,824	17,604	18,402	19,218	20,051
43	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14,256	14,983	15,729	16,493	17,274	18,074	18,892	19,728	20,582
44	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,379	16,143	16,926	17,726	18,546	19,384	20,240	21,116
45	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16,559	17,361	18,181	19,021	19,879	20,756	21,653
46	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17,798	18,638	19,497	20,376	21,274	22,191
47	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18,239	19,097	19,977	20,876	21,794	22,734
48	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19,560	20,458	21,378	22.317	23,278
49	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20,944	21,883	22,844	23,825
50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	22,390	23,372	24,374
51	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23,902	24,926
52	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	25,481

TABLE SHOWING THE CAPACITY OF STEEL LADLES AT EACH INCH OF THEIR DEPTH. RISE IN DIAMETER 1½ INCHES PER FOOT. LADLES FROM 2,500 TO 25,000 POUNDS CAPACITY

GAGING METAL IN STEEL LADLES

Table which gives the weight of steel in ladles at varying depths --- Constructing the table

BY JOSEPH BRETAUD

OWING to the great difficulty experienced in gaging accurately the amount of metal contained in a ladle, the writer recently compiled a table giving the weight of metal at varying depths, for the different ladles he used. This table has been in daily use in several foundries and has proven very valuable. Realizing that many steel founders, especially those using different compositions of steel, would welcome any data enabling them to gage in a very short time the weight of steel in their ladles, the writer decided to compile the accompanying elaborate tables. It gives the capacity of steel ladles from 20 inches to 55 inches diameter at the bottom, inside the lining, for every inch in depth, the assumed rise in diameter being 1½ inches to the foot.

Constructing the Table.

Engineering books give the weight of 1 cubic foot of cold steel as 490 pounds. The specific gravity of steel varies a little with the composition, especially with the percentage of carbon, high carbon steel being lighter than low carbon, but 490 pounds to the cubic foot may be taken as an average with a sufficient degree of accuracy. One cubic inch of cold steel consequently weighs $490 \div 1.728 = .283$ pounds. This co-efficient .283 is the one we use for figuring the weight in pounds of our castings by multiplying it by the volume of the casting in cubic inches.

In the present case we have to deal with molten steel instead of cold steel, and we know every metal shrinks in cooling or expands by heating. Therefore we must expect a cubic inch of molten steel to weigh less than a cubic inch of cold steel, since the molecules are in an expanded condition. This expansion is the most important factor which has to be taken into consideration. The rise in volume of a metal heated from a certain temperature to another temperature is given by the following formula:

$$Vt = Vt. \times C_3 \times (T\text{-}t)$$

in which Vt and t are the initial volume and temperature, Vt and T the final volume and temperature, and C_3 the co-efficient of cubical expansion.

Assuming the initial or normal temperature to be 70 degrees Fahr., and the final temperature, or that of the steel in the ladle to be 2,970 Fahr., the rise in temperature (T-t) will be 2,900 Fahr.

The co-efficient of lineal expansion of cast steel is C = .00000636. This is the expansion of one unit in length for a rise in temperature of 10 degrees Fahr. To find the co-efficient of cubical expansion, or expansion of volume, we will suppose a cube of dimension 1, and will call its co-efficient of lineal expansion C. Then for a rise of 1 degree Fahr., the new dimension is 1 + C, and the volume is $(1 + C)^3$.

$(1 + C)^3 = 1^3 + (3 \times 1^2 \times C) + (3 \times 1 \times C^2) + C^3$. C being small, C^2 and C^3 are very small and the two last quantities can be disregarded.

We get $(1 + C)^3 = 1^3 + (3 \times 1^2 \times C) = 1 + 3$ C. Then 3 C represents the rise in volume or the co-efficient of cubical expansion, which is practically three times the lineal expansion, or

$$C_3 = .00000636 \times 3 = .00001908$$

Considering the initial volume to be 1 cubic inch and substituting the values in the above formula, we have

$$Vt = 1 \times .00001908 \times 2900 = .055$$

The new volume is then 1.055. The weight remained evidently the same, therefore the weight of 1 cubic inch of molten steel is

$$.283 \div 1{,}055 = .268 \text{ pounds.}$$

Volume of a Ladle.

The ladle, assuming the shape of a frustrum of a cone to find its volume, we must add together the areas of the two bases and a mean proportional between them, and multiply the sum by one-third of the altitude:

$$\text{Volume} = 1/3\, a\left(\frac{\pi C^2}{4} + \frac{\pi C^2}{4} + \sqrt{\frac{\pi C^2 \times \pi C^2}{16}}\right)$$

Or,

$$\text{Volume} = .2618\, a\, (C^2 + C^2 + bc)$$

In these formulas a is the altitude, b and c the diameters of the two bases.

Suppose we want the volume of a ladle 32 inches in diameter at the bottom, and 36 inches deep. Assuming the rise in diameter to be 1½ inches to the foot, for 36 inches it is 4½ inches. Then the top diameter is 36½ inches.

$$\text{Volume} = .2618 \times 36\ [(32^2 + 36.5^2 + (32 \times 36.5)]$$
$$= .2618 \times 36 \times 3524.25$$
$$= 33215 \text{ cubic inches.}$$

Multiplying by .268 we get 8,901 pounds, as the weight of molten metal.

However, in order to construct the accompanying table we have not found it advisable to use this method for figuring the volume as it would have taken several weeks of hard work. We figured instead the average diameter of the ladle, which in this case is 34¼ inches, and multiplied the area of this circle by the height, giving:

$$\text{Volume} = 921.32 \times 36 = 33167 \text{ cubic inches.}$$

Multiplying by .268 we get 8,889 pounds of molten steel. We thus have a result slightly lower than the true weight found by the first method, but this is close enough for our purpose, inasmuch as we are on the safe side.

This method of figuring the volume of molten steel at different depths has been used throughout the work. The weight is then given by the formula:

Weight = area of average circle x depth x .268.

The area being given in square inches and the depth in inches.

Furthermore, the product of depth by .268 has been first figured separately for all depth from 1 to 70 inches and these products have been multiplied by the area of the average circle for each separate case. This method gives results independent of those previously obtained, being, there-

fore, superior to the one which consists of figuring the weight of a 1-inch thickness of steel at different depths and adding all these weights together, as the chances of accumulation of small errors are obviated.

If a given amount of metal is to be tapped into a ladle the better way is to get from the table the depth of metal for the ladle used and mark it on the lining with a piece of chalk. An iron rod whose length is the difference between the height of the ladle and that found in the table can be used, bent at right angles at one end to hang it from the lip.

If the inverse problem has to be met, that is to find the weight of metal contained in a ladle, the depth of metal can be gaged with two bars, one horizontal resting on top of the ladle and one held vertically to find the distance from the top of the level of the bath. By subtraction, the depth of metal is found and hence the weight. The special gage bar described in the March issue of THE FOUNDRY may be found convenient. If one does not want to go to the trouble of making one for every ladle in the shop, a single bar with inches marked on can answer the same purpose, by making the following tables for each size of ladle in use. Take from the accompanying tables the number corresponding to the diameter and total height of the ladle in question, and copy the column of numbers backwards, that is, the last number be the one given for 1 inch depth. It will be seen that this new table will immediately give the weight of metal when the distance from the level of the bath to the top has been gaged.

DIAMETER OF LADLE AT THE BOTTOM IN INCHES.

Steel in ladle, inches.	46	47	48	49	50	51	52	53	54	55
1	446	466	486	507	527	549	570	592	615	638
2	895	935	975	1,016	1,058	1,100	1,144	1,188	1,233	1,279
3	1,347	1,406	1,466	1,528	1,590	1,654	1,720	1,786	1,854	1,923
4	1,801	1,880	1,960	2,042	2,126	2,211	2,298	2,387	2,478	2,570
5	2,257	2,356	2,456	2,559	2,664	2,771	2,880	2,991	3,104	3,220
6	2,716	2,834	2,955	3,079	3,205	3,333	3,464	3,598	3,734	3,872
7	3,177	3,315	3,457	3,601	3,748	3,898	4,051	4,207	4,366	4,528
8	3,641	3,799	3,961	4,126	4,294	4,466	4.641	4,819	5,001	5,187
9	4,107	4,285	4,467	4,653	4,843	5,036	5,234	5,435	5,640	5,848
10	4,576	4,774	4,977	5,183	5,394	5,610	5,829	6,053	6,280	6,512
11	5,047	5,265	5,488	5,716	5,949	6,186	6,427	6,673	6.924	7,180
12	5,520	5,759	6,002	6,251	6,505	6,764	7,082	7,297	7,571	7,850
13	5,996	6,255	6,519	6,790	7,065	7,345	7,632	7,923	8,221	8,524
14	6,474	6,754	7,039	7,330	7,627	7,930	8,238	8,553	8,873	9,200
15	6,956	7,256	7,561	7,873	8,192	8,517	8,848	9,185	9,529	9,879
16	7,439	7,759	8,086	8,419	8,759	9,106	9,460	9,820	10,187	10,561
17	7,925	8,266	8,613	8,968	9,329	9,698	10,075	10,458	10,848	11,246
18	8,414	8,775	9,143	9,519	9,902	10,294	10,693	11,099	11,513	11,934
19	8,905	9,286	9,676	10,073	10,479	10,892	11,313	11,743	12,180	12,625
20	9,398	9,800	10,211	10,630	11,057	11,493	11,937	12,389	12.850	13,319
21	9,894	10,317	10,749	11,189	11,638	12,096	12,563	13,039	13,523	14,017
22	10,392	10,836	11,289	11,751	12,222	12,703	13,192	13,691	14,199	14,717
23	10,894	11,358	11,832	12,315	12,808	13,311	13,824	14,346	14,878	15,420
24	11,398	11,883	12,377	12,883	13,398	13,924	14,459	15,004	15,560	16,126
25	11,904	12,410	12,926	13,453	13,990	14,538	15,097	15,666	16,246	16,835
26	12,413	12,939	13,477	14,026	14,585	15,156	15,737	16,329	16,933	17,547
27	12,924	13,472	14,031	14,601	15,183	15,776	16,381	16,996	17,624	18,262
28	13,438	14,006	14,587	15,179	15,783	16,399	17,027	17,666	18,317	18,980
29	13,954	14,543	15,146	15,760	16,386	17,025	17,676	18,339	19,014	19,702
30	14,473	15,084	15,707	16,343	16,992	17,654	18,327	19,014	19,714	20,426
31	14,995	15,626	16,272	16,930	17,601	18,286	18,983	19,693	20,416	21,153
32	15,519	16,172	16,839	17,519	18,213	18,920	19,640	20,374	21,122	21,884
33	16,046	16,720	17,408	18,110	18,827	19,557	20,301	21,059	21,831	22,617
34	16,574	17,270	17,980	18,704	19,443	20,197	20,964	21,746	22,542	23.353
35	17,106	17,823	18,556	19,302	20,064	20,840	21,632	22,437	23,257	24,092
36	17,641	18,379	19,133	19,902	20,687	21,486	22,301	23,130	23,975	24,835
37	18,178	18,938	19,714	20,505	21,312	22,135	22,973	23,827	24,696	25,581
38	18,717	19,499	20,297	21,111	21,941	22,786	23,648	24,526	25,420	26,329
39	19,259	20,063	20,882	21,719	22,571	23,441	24,327	25,228	26,147	27,081
40	19,805	20,629	21,471	22,331	23,206	24,098	25,007	25,934	26,876	27,836
41	20,352	21,199	22,062	22,944	23,842	24,759	25,692	26,642	27,609	28,594
42	20,902	21,771	22,656	23,560	24,482	25,421	26,378	27,352	28,345	29,355
43	21,455	22,344	23,254	24,180	25,124	26,087	27,068	28,067	29,085	30,119
44	22,009	22,922	23,853	24,802	25,770	26,757	27,761	28,785	29,826	30,887
45	22,567	23,502	24,455	25,427	26,418	27,428	28,457	29,505	30,572	31,657
46	23,128	24,084	25,059	26,054	27,069	28,102	29,155	30,228	31,319	32,430
47	23,691	24,670	25,667	26,685	27,723	28,780	29,857	30,954	32,071	33,207
48	24,257	25,258	26,278	27,319	28,380	29,461	30,561	31,683	32,826	33,988
49	24,827	25,848	26,891	27,955	29,039	30,144	31,269	32,416	33,583	34,770
50	25,398	26,442	27,507	28,594	29,702	30,830	31,980	33,152	34,343	35,557
51	25,972	27,039	28,127	29,237	30,367	31,521	32,695	33,889	35,107	36,346
52	26,548	27,637	28,748	29,881	31,035	32,213	33,411	34,630	35,874	37,138
53	27,128	28,239	29,372	30,528	31,707	32,907	34,130	35,376	36,642	37,933
54	27,709	28,844	30,000	31,179	32,380	33,605	34,852	36,123	37,416	38,732
55	.....	29,451	30,629	31,832	33,058	34,307	35,579	36,874	38,192	39,533
56	.....	30,060	31,262	32,488	33,737	35,010	36,306	37,627	38,970	40,338
57	.....	.....	31,897	33,147	34,421	35,718	37,039	38,383	39,753	41,147
58	.....	.....	32,536	33,809	35,106	36,427	37,773	39,143	40,538	41,957
59	.....	.....	.....	34,473	35,795	37,140	38,511	39,907	41,327	42,773
60	.....	.....	.....	35,141	36,487	37,857	39,252	40,672	42,120	43,591
61	.....	.....	.....	.....	37,180	38,756	39,997	41,442	42,914	44,410
62	.....	.....	.....	.....	37,877	39,297	40,743	42,214	43,711	45,235
63	.....	.....	.....	.....	.....	40,022	41,492	42,990	44,513	46,062
64	.....	.....	.....	.....	.....	40,749	42,245	43,768	45,317	46,894
65	.....	.....	.....	.....	.....	.....	43,001	44,550	46,124	47,727
66	.....	.....	.....	.....	.....	.....	.....	45,333	46,935	48,564
67	.....	.....	.....	.....	.....	.....	.....	46,121	47,748	49,403
68	.....	.....	.....	.....	.....	.....	.....	.....	48,564	50,246
69	.....	.....	.....	.....	.....	.....	.....	.....	49,384	51,092
70	.....	.....	.....	.....	.....	.....	.....	.....	.....	51,941

TABLE SHOWING CAPACITY OF STEEL LADLES AT EACH INCH OF THEIR DEPTH
LADLES FROM 25,000 TO 50,000 POUNDS CAPACITY

PENDULUM CASTINGS.

Question:—The pendulum castings we are making are entirely too brittle and hard. We are using a mixture consisting of one ounce of lead to one pound of zinc. We cast in green sand. The castings we are making have a core running through the center about 1 inch long and ½ inch thick. They are to be cast from the cheapest metal possible. Can you suggest a good mixture?

Answer:—I believe the trouble is with the zinc you are using. It may contain impurities such as iron or copper, which would have a tendency to harden it. So far as I could determine by experiments, the sample casting received was no different from an alloy I made from your formula. Lead and zinc will not alloy, and lead is the only metal that could be used in this case. Any increase of lead above one ounce to 16 of zinc is made with difficulty. You might try the following alloy: To 10 pounds of melted zinc add one pound of lead, stir and add two ounces of stick phosphorus, and pour this mixture into ingots. Remelt for use and for every 50 pounds of melted alloy add one pound of plaster of Paris. After adding the plaster of Paris, wait until the same has been heated, then stir, and continue stirring until reaction has taken place. Little red eruptions will appear here and there and the zinc will flare. The metal should then be removed from the fire and allowed to cool to a casting temperature. K. K.

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Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

PATTERN SIZE AND WEIGHT OF CAST IRON PIPE, 5/16 to 1 1/32 INCHES THICK

Thickness, inches.		5/16	11/32	3/8	13/32	7/16	15/32	1/2	17/32	9/16	19/32	5/8	21/32	11/16	23/32	3/4	25/32	13/16	27/32	7/8	29/32	15/16	31/32	1	1 1/32
3-inch Pipe	Pattern size, inches	3 13/32	3 23/32	3 13/16	3 29/32	4 5/16	4 11/32	4 3/8	4 13/32	4 7/16	4 15/32	4 1/2	4 17/32	4 9/16	4 19/32	4 5/8	4 21/32	4 11/16	4 23/32	4 3/4	4 25/32	4 13/16	4 27/32	4 7/8	4 29/32	5 15/16	5 31/32	....
	Weight, pounds....	132	147	162	177	193	208	224	240	256	272	288	306	324	342	360	378	396	415	434	453	472	491	511	....
4-inch Pipe	Pattern size, inches	4 13/32	4 23/32	4 13/16	4 29/32	5 5/16	5 11/32	5 3/8	5 13/32	5 7/16	5 15/32	5 1/2	5 17/32	5 9/16	5 19/32	5 5/8	5 21/32	5 11/16	5 23/32	5 3/4	5 25/32	5 13/16	5 27/32	5 7/8	5 29/32	6 5/16	6 5/16	6 5/8
	Weight, pounds....	172	191	210	229	248	268	288	308	328	349	370	390	412	434	456	478	500	522	545	568	591	615	639	663
5-inch Pipe	Pattern size, inches	5 13/32	5 23/32	5 13/16	5 29/32	6 5/16	6 5/16	6 3/8	6 7/16	6 7/16	6 15/32	6 1/2	6 17/32	6 9/16	6 19/32	6 5/8	6 21/32	6 11/16	6 23/32	6 3/4	6 25/32	6 13/16	6 27/32	6 7/8	6 29/32	7 5/16	7 5/16	7 5/8
	Weight, pounds....	212	235	258	281	304	328	351	376	400	425	450	474	500	525	551	577	604	631	657	684	711	734	767	795
6-inch Pipe	Pattern size, inches	6 3/4	6 13/16	6 7/8	6 15/16	7	7 1/16	7 1/16	7 1/16	7 1/16	7 1/16	7 1/16	7 1/16	7 1/16	7 1/16	7 1/16	7 1/16	7 1/16	7 3/16	7 1/16	7 3/16	7 1/16	7 3/16	7 1/16	7 3/16	8	8 1/16	8 1/16	8 1/16
	Weight, pounds....	253	279	306	333	360	389	416	444	472	500	529	558	587	617	647	677	708	738	769	802	837	863	895	932
7-inch Pipe	Pattern size, inches	7 1/4	7 1/16	7 3/16	7 1/16	8	8 1/16	8 1/16	8 1/16	8 1/16	8 1/16	8 1/16	8 1/16	8 1/16	8 1/16	8 1/16	8 1/16	8 1/16	8 5/16	8 1/16	8 1/16	8 1/16	8 1/16	8 1/16	8 1/16	9	9 1/16	9 1/16	9 1/16
	Weight, pounds....	292	323	354	385	416	448	479	513	545	577	610	643	676	709	743	777	811	846	880	916	951	987	1023	1059
8-inch Pipe	Pattern size, inches	8 1/4	8 1/16	8 3/16	8 1/16	8	9 1/16	9 1/16	9 1/16	9 1/16	9 1/16	9 1/16	9 1/16	9 1/16	9 1/16	9 1/16	9 1/16	9 1/16	9 1/16	9 1/16	9 1/16	9 1/16	9 1/16	9 1/16	9 1/16	10	10 1/16	10 1/16	10 1/16
	Weight, pounds....	332	367	401	435	471	507	543	579	616	652	689	726	765	801	839	877	916	954	993	1032	1071	1111	1151	1189
9-inch Pipe	Pattern size, inches	9 1/16	9 1/16	9 1/16	10	10 1/16	10 1/16	10 1/16	10 1/16	10 1/16	10 1/16	10 1/16	10 1/16	10 1/16	10 1/16	10 1/16	10 1/16	10 1/16	10 1/16	10 1/16	10 1/16	10 1/16	11	11 1/16	11 1/16	11 1/16	11 1/16	11 1/16	11 1/16
	Weight, pounds....	371	411	449	488	528	567	607	648	688	728	769	810	851	893	935	977	1019	1062	1105	1148	1191	1234	1278	1322
10-inch Pipe	Pattern size, inches	10 1/16	10 1/16	10 1/16	11	11 1/16	11 1/16	11 1/16	11 1/16	11 1/16	11 1/16	11 1/16	11 1/16	11 1/16	11 1/16	11 1/16	11 1/16	11 1/16	11 1/16	11 1/16	11 1/16	11 1/16	12	12 1/16	12 1/16	12 1/16	12 1/16	12 1/16	12 1/16
	Weight, pounds....	412	455	497	540	584	627	671	715	759	804	849	893	939	985	1032	1077	1123	1170	1216	1263	1311	1358	1406	1454
12-inch Pipe	Pattern size, inches	....	12 3/16	12 3/16	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16	14 1/16	14 1/16	14 1/16	14 1/16	14 1/16
	Weight, pounds....	....	542	594	644	695	747	799	851	903	956	1008	1062	1115	1168	1222	1277	1331	1385	1440	1495	1550	1606	1662	1718
14-inch Pipe	Pattern size, inches	....	....	15	15 1/16	15 1/16	15 1/16	15 1/16	15 1/16	15 1/16	15 1/16	15 1/16	15 1/16	15 1/16	15 1/16	15 1/16	15 1/16	15 1/16	15 1/16	15 1/16	15 1/16	15 1/16	16	16 1/16	16 1/16	16 1/16	16 1/16	16 1/16	16 1/16
	Weight, pounds....	....	....	689	748	807	867	927	987	1047	1108	1159	1230	1291	1352	1414	1476	1538	1601	1664	1727	1790	1853	1917	1982
16-inch Pipe	Pattern size, inches	....	....	....	17 1/16	17 1/16	17 1/16	17 1/16	17 1/16	17 1/16	17 1/16	17 1/16	17 1/16	17 1/16	17 1/16	17 1/16	17 1/16	17 1/16	17 1/16	17 1/16	17 1/16	18	18 1/16	18 1/16	18 1/16	18 1/16	18 1/16	18 1/16	18 1/16
	Weight, pounds....	....	....	....	852	919	987	1055	1123	1191	1259	1329	1397	1466	1536	1606	1676	1746	1817	1888	1958	2030	2101	2173	2245
18-inch Pipe	Pattern size, inches	....	....	....	....	19 1/16	19 1/16	19 1/16	19 1/16	19 1/16	19 1/16	19 1/16	19 1/16	19 1/16	19 1/16	19 1/16	19 1/16	19 1/16	19 1/16	19 1/16	19 1/16	20	20 1/16	20 1/16	20 1/16	20 1/16	20 1/16	20 1/16	20 1/16
	Weight, pounds....	....	....	....	....	1031	1106	1182	1258	1335	1411	1488	1562	1642	1720	1798	1876	1954	2032	2111	2190	2269	2349	2429	2509
20-inch Pipe	Pattern size, inches	....	....	....	....	....	21 1/16	21 1/16	21 1/16	21 1/16	21 1/16	21 1/16	21 1/16	21 1/16	21 1/16	21 1/16	21 1/16	21 1/16	21 1/16	21 1/16	21 1/16	22	22 1/16	22 1/16	22 1/16	22 1/16	22 1/16	22 1/16	22 1/16
	Weight, pounds....	....	....	....	....	....	1226	1310	1394	1479	1563	1648	1732	1818	1903	1987	2075	2160	2246	2333	2420	2508	2596	2684	2778
22-inch Pipe	Pattern size, inches	....	....	....	....	....	....	23 1/16	23 1/16	23 1/16	23 1/16	23 1/16	23 1/16	23 1/16	23 1/16	23 1/16	23 1/16	23 1/16	23 1/16	23 1/16	23 1/16	24	24 1/16	24 1/16	24 1/16	24 1/16	24 1/16	24 1/16	24 1/16
	Weight, pounds....	....	....	....	....	....	....	1437	1529	1622	1715	1808	1901	1994	2088	2182	2276	2370	2464	2558	2653	2748	2844	2940	3038
24-inch Pipe	Pattern size, inches	....	....	....	....	....	....	....	25 1/16	25 1/16	25 1/16	25 1/16	25 1/16	25 1/16	25 1/16	25 1/16	25 1/16	25 1/16	25 1/16	25 1/16	25 1/16	26	26 1/16	26 1/16	26 1/16	26 1/16	26 1/16	26 1/16	26 1/16
	Weight, pounds....	....	....	....	....	....	....	....	1666	1766	1867	1968	2069	2171	2271	2373	2475	2577	2679	2782	2883	2989	3092	3195	3299
30-inch Pipe	Pattern size, inches	....	....	....	....	....	....	....	....	31 1/16	31 1/16	31 1/16	31 1/16	31 1/16	31 1/16	31 1/16	31 1/16	31 1/16	31 1/16	31 1/16	31 1/16	32	32 1/16	32 1/16	32 1/16	32 1/16	32 1/16	32 1/16	32 1/16
	Weight, pounds....	....	....	....	....	....	....	....	....	2198	2322	2447	2572	2697	823	2948	3075	3201	3327	3453	3580	3707	3834	3962	4090
36-inch Pipe	Pattern size, inches	....	....	....	....	....	....	....	....	....	....	....	....	....	37 1/16	37 1/16	37 1/16	37 1/16	38	38 1/16	38 1/16	38 1/16	38 1/16	38 1/16	38 1/16	38 1/16	38 1/16	38 1/16
	Weight, pounds....	....	....	....	....	....	....	....	....	....	....	....	....	....	3072	3222	3372	3523	3674	3825	3976	4122	4279	4431	4583	4735	4887

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PATTERN SIZE AND WEIGHT OF CAST IRON PIPE, 1 1/16 TO 1¾ INCHES THICK

Thickness, inches.		1 1/16	1 1/16	1 1/16	1 3/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16
3-inch Pipe	Pattern size, inches	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	Weight, pounds....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
4-inch Pipe	Pattern size, inches	6 9/16	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	Weight, pounds....	687	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
5-inch Pipe	Pattern size, inches	7 7/16	7 7/16	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	Weight, pounds....	823	851	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
6-inch Pipe	Pattern size, inches	8 1/16	8 1/16	8 3/16	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	Weight, pounds....	959	992	1025	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
7-inch Pipe	Pattern size, inches	9 1/16	9 1/16	9 3/16	9 1/16	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	Weight, pounds....	1095	1132	1168	1206	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
8-inch Pipe	Pattern size, inches	10 1/16	10 1/16	10 3/16	10 1/16	10 1/16	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	Weight, pounds....	1230	1271	1312	1353	1395	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
9-inch Pipe	Pattern size, inches	11 1/16	11 1/16	11 1/16	11 1/16	11 1/16	11 1/16	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	Weight, pounds....	1366	1411	1456	1501	1547	1593	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
10-inch Pipe	Pattern size, inches	12 1/16	12 1/16	12 1/16	12 1/16	12 1/16	12 1/16	12 1/16	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	Weight, pounds....	1503	1551	1600	1649	1698	1747	1797	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
12-inch Pipe	Pattern size, inches	14 1/16	14 1/16	14 1/16	14 1/16	14 1/16	14 1/16	14 1/16	14 1/16	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	Weight, pounds....	1774	1831	1887	1944	2001	2059	2117	2175	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
14-inch Pipe	Pattern size, inches	16 1/16	16 1/16	16 1/16	16 1/16	16 1/16	16 1/16	16 1/16	16 1/16	16 1/16	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	Weight, pounds....	2046	2110	2175	2240	2305	2371	2437	2502	2569	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
16-inch Pipe	Pattern size, inches	18 1/16	18 1/16	18 1/16	18 1/16	18 1/16	18 1/16	18 1/16	18 1/16	18 1/16	18 1/16	19	....	....	....	....	....	....	....	....	....	....	....	....	....
	Weight, pounds....	2317	2380	2463	2536	2609	2683	2757	2831	2905	2979	3054	....	....	....	....	....	....	....	....	....	....	....	....	....
18-inch Pipe	Pattern size, inches	20 1/16	20 1/16	20 1/16	20 1/16	20 1/16	20 1/16	20 1/16	20 1/16	20 1/16	20 1/16	21	21 1/16	....	....	....	....	....	....	....	....	....	....	....	....
	Weight, pounds....	2589	2669	2750	2831	2913	2995	3076	3158	3240	3322	3405	3488	....	....	....	....	....	....	....	....	....	....	....	....
20-inch Pipe	Pattern size, inches	22 1/16	22 1/16	22 1/16	22 1/16	22 1/16	22 1/16	22 1/16	22 1/16	22 1/16	23	23 1/16	23 1/16	23 1/16	23 1/16	....	....	....	....	....	....	....	....	....	....
	Weight, pounds....	2861	2949	3038	3127	3216	3306	3396	3486	3576	3666	3757	3848	3939	4030	....	....	....	....	....	....	....	....	....	....
22-inch Pipe	Pattern size, inches	24 1/16	24 1/16	24 1/16	24 1/16	24 1/16	24 1/16	24 1/16	24 1/16	24 1/16	25	25 1/16	25 1/16	25 1/16	25 1/16	....	....	....	....	....	....	....	....	....	....
	Weight, pounds....	3132	3229	3326	3423	3520	3617	3715	3813	3912	4010	4109	4208	4307	4406	4506	....	....	....	....	....	....	....	....	....
24-inch Pipe	Pattern size, inches	26 1/16	26 1/16	26 1/16	26 1/16	26 1/16	26 1/16	26 1/16	26 1/16	26 1/16	27	27 1/16	27 1/16	27 1/16	27 1/16	27 1/16	27 1/16	27 1/16	....	....	....	....	....	....	....
	Weight, pounds....	3403	3507	3612	3717	3822	3928	4034	4140	4246	4352	4459	4566	4674	4782	4890	4998	5106	....	....	....	....	....	....	....
30-inch Pipe	Pattern size, inches	32 1/16	32 1/16	32 1/16	32 1/16	32 1/16	32 1/16	32 1/16	32 1/16	33	33 1/16	33 1/16	33 1/16	33 1/16	33 1/16	33 1/16	33 1/16	33 1/16	33 1/16	33 1/16	....	....	....	....	....
	Weight, pounds....	4218	4347	4476	4605	4734	4863	4993	5123	5253	5384	5515	5646	5777	5908	6040	6172	6304	6436	6569	....	....	....	....	....
36-inch Pipe	Pattern size, inches	38 1/16	38 1/16	38 1/16	38 1/16	38 1/16	38 1/16	38 1/16	39	39 1/16	39 1/16	39 1/16	39 1/16	39 1/16	39 1/16	39 1/16	39 1/16	39 1/16	39 1/16	39 1/16	39 1/16	39 1/16	39 1/16	39 1/16	39 1/16
	Weight, pounds....	5040	5193	5346	5499	5652	5806	5960	6114	6268	6428	6576	6731	6886	7041	7196	7351	7507	7663	7829	7985	8141	8298	8455	

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Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

THE MOLDING OF LOCOMOTIVE CYLINDERS

Methods of overcoming imperfections in these difficult sections — Making the patterns and metal mixtures

BY LOUIS LUHRSEN

THE CONSTRUCTION of locomotives has undergone many changes during the past 25 or 30 years. The castings used today are not only heavier but more intricate and difficult to mold than those used in the earlier types of locomotives. Locomotive castings are subjected to a tremendous strain when the engine is pulling a heavy train, especially on a grade. The average molder evidently does not realize the importance of making these castings as nearly perfect as possible and he is frequently careless with his work while pouring the molds. When one sees heavy cylinder heads bursting, guides snapping, eccentric straps breaking and frequently the cylinders themselves ripping from one flange to the other, the strains on these castings can better be appreciated.

Strength and Wearing Qualities.

Strength and wearing qualities are the two most important factors to be considered in the production of locomotive castings. Some attention should, of course, be given to the appearance of the casting, but strength and wearing qualities are the essentials which should be sought for by every foundryman engaged in this line of work.

The cylinder is by far the most important casting entering into the construction of a locomotive. The majority of these are molded in dry sand in special flasks, cut to suit the pattern wherever it is necessary to make a parting. These flasks are also made to conform to the shape and size of the cylinders to reduce to the minimum the amount of sand required. A cylinder mold well finished is one of the most artistic jobs in foundry work, and when the uninitiated sees all the cores which belong to it he wonders how it is possible to get them all into the mold. The inlet core with its long neck is especially interesting, while the exhaust core has about the same length. Both these cores are set in place before the mold is set into the oven.

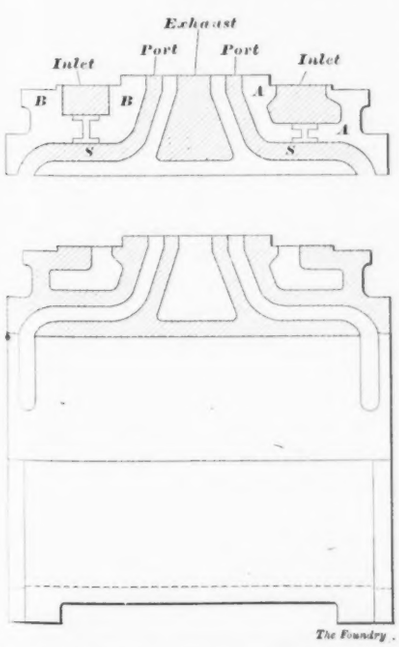


FIG. 1—PROPER AND IMPROPER METAL THICKNESSES OF LOCOMOTIVE CYLINDER CASTINGS

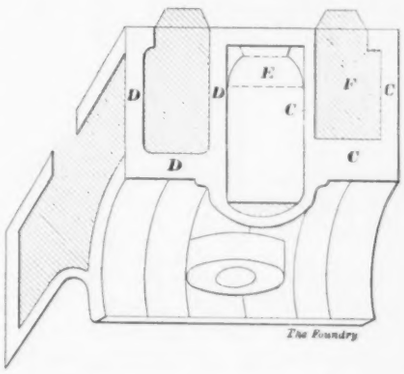


FIG. 2—SECTION OF LOCOMOTIVE CYLINDER SHOWING METAL THICKNESSES

The successful making of locomotive cylinders embraces many points in foundry work which can be used to advantage in the production of other castings of a similar nature. During the past 20 years we have made a large number of these castings and have lost only one, and this was due to the breaking away of a portion of the port core from the core rod.

The Pattern

Thus far we have considered cylinder molding in general. In taking up the details we should consider the pattern first. A pattern of this kind cannot possibly be made too strong as it is frequently in almost daily use from 10 to 20 years. On account of the hard ramming it should be well braced and all sharp corners should be avoided wherever possible. The pattern should be washed, sand papered and varnished frequently and it should be kept in good condition at all times. The core boxes should likewise be kept in good condition.

Core prints should be long and well tapered. This will prove a great aid to the molder in entering his core. The print should be made large enough to permit the core to enter freely and with a small amount of thin paste around the core all fins can be obviated and run-outs safely guarded against. When ramming a cylinder mold, facing sand to a depth of 1½ inches put through a No. 6 sieve should be used next to the pattern. The backing sand should consist of two parts of old sand and one part of new sand. Layers of coke or cinders are used every six or eight inches. This not only reduces the amount of sand required, but is an aid in drying the mold and in taking off the vents. When ram-

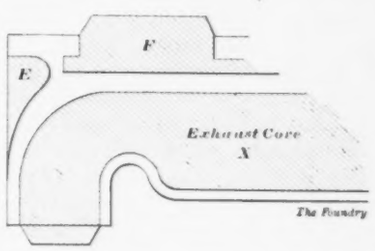


FIG. 3—PART OF CYLINDER FREQUENTLY BROKEN, DUE TO POOR CONSTRUCTION

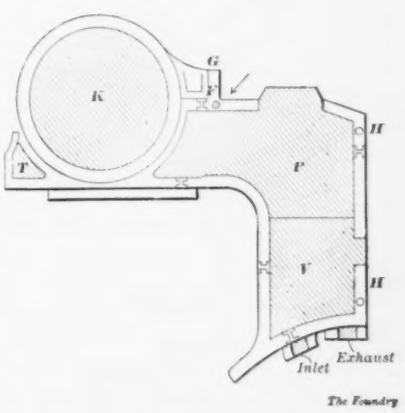


FIG. 4—VIEW SHOWING SECTION OF CYLINDER FREQUENTLY CONTAINING SHRINK HOLES

ming the mold the pean of the rammer should remain at least an inch away from the pattern and the butt, ½ an inch. All corners and projections should be well rodded and nailed inasmuch as in drying the sharp corners will invariably

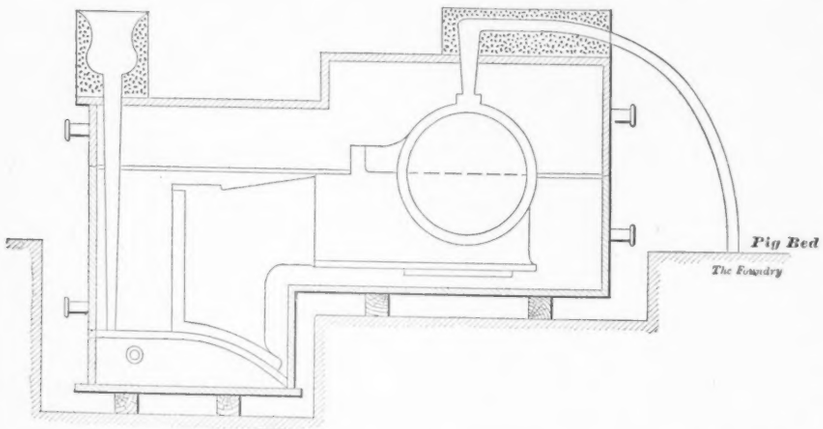


FIG. 5—METHOD OF MOLDING AND ARRANGEMENT OF GATES AND OVERFLOW TO PREVENT SHRINK HOLES

crack and if not secured the iron is liable to wash the mold away at this point. Most of this corner nailing can be done after the pattern has been drawn. It is customary to fin the edges of dry sand molds, that is, to cut down the mold ⅛ of an inch running back about 2½ inches to a feather edge. We have always found ⅛ inch "finning" sufficient, but have seen cylinders that showed ½ inch or more. This is uncalled for and makes an ugly looking casting. We employed a molder at one time who started to cut his fin ½ inch deep and when asked to give his reason for this replied "The sand in drying raised just that much." He was informed that we did not use yeast in our facing sand and to cut the fin not more than ⅛ of an inch. This molder was pleased with the "finning part" when the

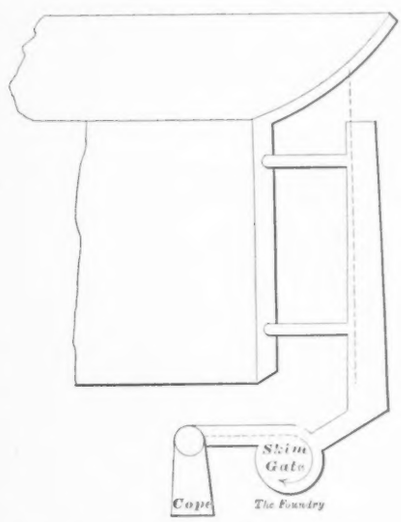


FIG. 6—PLAN OF ONE SIDE OF GATE

casting was shaken out and besides he had learned a new wrinkle in molding.

Finishing the Mold.

Locomotive cylinder molds generally require more than one day to make and when they are ready for blacking, the surface and corners have become very dry and crumble easily. It would be very difficult to attempt to blacken them with the assurance of a satisfactory job. First of all we wet the mold with a weak solution of molasses water, one pint to a bucket. The blacking is then applied evenly and this mixture should be of such a consistency that it will freely leave the brush. If mixed too thick it will roll under the brush. When slicking wet blacking with any kind of a tool it should be tilted up in front and the slicking proper should be done with the lower edge of the tool.

Setting the Cores.

When coring the mold we have made it a practice to set the inlet, exhaust and lower reducer cores in the mold before it is placed in the oven. On account of their long necks they are hard to stop-off around the print when the mold is dry, but this is done very easily while green. In setting cores in cylinder molds it is essential to have the metal as nearly the required thickness as possible. The majority of cylinders come to an untimely end not because they are worn out but because they crack through the ports and steam pipes. A cylinder can be bushed and valve seats can be renewed several times providing the casting is perfect. Poorly proportioned metal thicknesses in a casting of this kind are not so much the fault of the molder as that of the patternmaker.

About 12 years ago a certain railroad came into possession of 30 locomotives and after operating them a few months the cylinders cracked through the steam pipes, and sometimes in the sides. These cylinders were made in various contract shops. One day one of these locomotives was sent to the repair shop for a number of new cylinders. The patterns were sent for and our attention was especially directed to the cracking of the cylinders formerly used. The master mechanic stated that no trouble had previously been experienced with cylinders made in our foundry, and he could not understand why we should have so much trouble with cylinders made in contract shops. When making the molds everything moved along satisfactorily until we dried the cores and found that the metal thicknesses were so much out of proportion that it was a surprise to us that the castings did not crack in cooling. The metal thickness showed a variation from ½ inch to 3 inches. Two of the old cylinders were then broken under the drop and they were full of honeycombs. These places were filled with lead and babbit metal. The corners of the cored openings were sharp and no fillets were used. The core boxes were then reconstructed to insure a uniform thickness of metal and large fillets were used whenever necessary. We have since made about 30 of these castings from this pattern with our own metal mixture and as yet not a cylinder has cracked.

Cylinder Imperfections.

The honeycombing of cylinders due to poorly proportioned metal thicknesses is shown in Fig. 1. The proper metal thickness is illustrated at A A, and the improper thickness at B B. A comparison of C C C with D D D, Fig. 2, will show

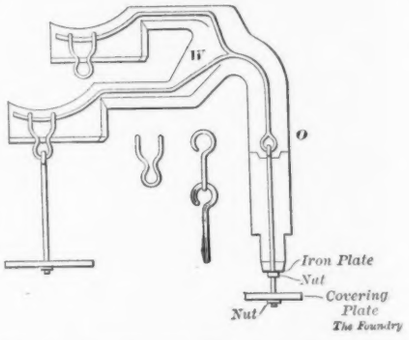


FIG. 7—DEVICE FOR HOLDING INLET CORE

why the cylinders crack when subjected to full steam pressure. The point E over the exhaust core, Fig. 3, is sometimes left solid which frequently results in the cracking of the cylinder at F. All danger, however, can be obviated and this difficulty overcome by coring out as shown at E, Fig. 2. The section F, Fig. 4, is liable to contain shrink holes on account of the heavy flange G to which the locomotive frame is bolted. This is called the frame seat and flaws in this part of

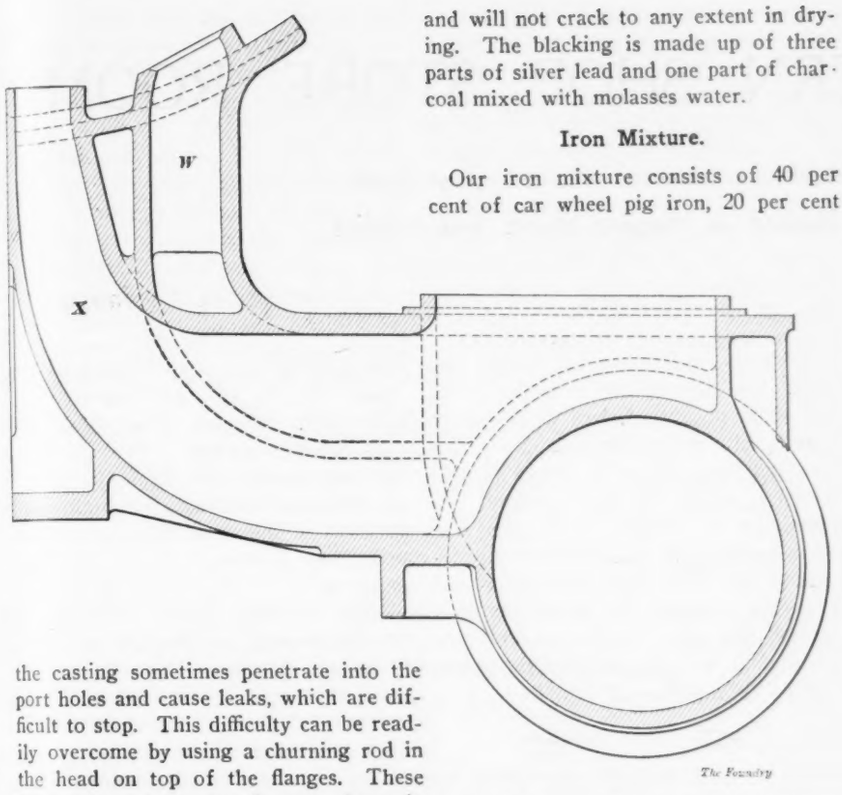


FIG. 8—CROSS SECTION OF LOCOMOTIVE CYLINDER CASTING

the casting sometimes penetrate into the port holes and cause leaks, which are difficult to stop. This difficulty can be readily overcome by using a churning rod in the head on top of the flanges. These heads also cut our overflows as shown in Fig. 5. When casting these cylinders we bank up the overflow, fill the head with solid metal and churn both flanges until the casting is set.

Gates and Pouring Basin.

The arrangement of the gates is shown in Fig. 6, as well as at H H, Fig. 4. The area of the pouring basin is much greater than the combined area of the gates and, therefore, when the basin is kept full of iron it is almost impossible for dirt and slag to get into the casting. The pouring basin should be treated as a part of the mold, inasmuch as the making of a green sand basin that will permit of the pouring of several tons of metal is quite an accomplishment. If the basin is rammed too hard the iron will squirt and if too soft it may find its way to the bottom plates, upon which the box rests. In both cases the results may prove fatal to the casting. In making the basins for our molds we clay wash the box, ram it up with heap sand put through a No. 4 sieve and cut it out to the desired size with a trowel. In front it should be undercut a trifle to keep the iron from splashing out. The box should also be clamped to the plate to avoid any possibility of its raising.

Facing Sand Mixture.

The facing sand mixture used for making the mold follows: Twelve parts of new molding sand, five parts of sharp sand and four parts of old heap sand run through a No. 4 sieve, wet down with a thin clay wash. This is an open mixture and will not crack to any extent in drying. The blacking is made up of three parts of silver lead and one part of charcoal mixed with molasses water.

Iron Mixture.

Our iron mixture consists of 40 per cent of car wheel pig iron, 20 per cent of car wheel scrap and 40 per cent of medium soft machinery scrap. We do not use the rims of car wheels which show a chill much above three-quarters of an inch. The fins on our castings are slightly chilled but the chill does not extend into the casting and no trouble is, therefore, experienced in machining them. This mixture has given satisfaction for many years both on the valve faces and in the bores of the cylinder. The boiler seat, which requires considerable chipping, is a trifle hard, but this does not seriously interfere with the finishing.

The inlet core W, Figs. 7 and 8, is made up solid to the point O and the other part of the neck is bolted to it in the manner shown. In Fig. 4, P and N show the upper and lower reducer cores respectively. Core T reduces the metal between the name plate and barrel core K. The term reducer is used here to designate these cores more clearly as they are used to reduce metal thicknesses and to insure the proper proportions.

COURSE IN FOUNDRY PRACTICE.

The Young Men's Christian Association, Hamilton, O., has outlined a course in foundry practice which is designed for molders, apprentices and core makers. The course includes 24 lessons and encompasses many of the problems daily confronting the molder. The course is in charge of James A. Murphy, superintendent of the Hooven, Owens, Rentschler Co., who, by training and experience, is well qualified to undertake this work.

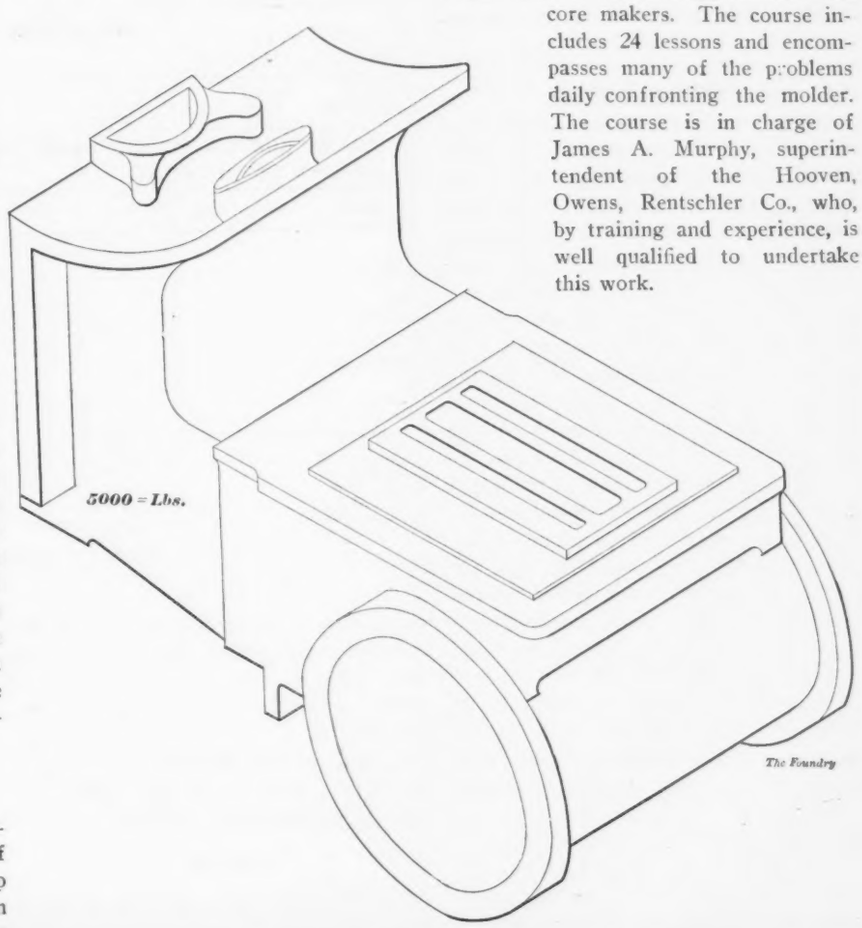


FIG. 9—FINISHED LOCOMOTIVE CYLINDER CASTING

THE PATTERN SHOP STORE ROOM

Conduct of this essential and important department—Method of charging lumber and supplies

BY OSCAR E. PERRIGO

IN THIS discussion of supplies withdrawn from the store room it is not intended to limit the kind or nature of the articles secured from the storekeeper, or the use for which they are intended. Nor is the source from which they are secured to be restricted, regardless of whether they are withdrawn from the store room proper, the lumber yard, the machine or forge shop, the iron or brass foundry, or whether the articles have been especially purchased for use on a special order.

The term supplies includes all articles purchased or made upon the premises for use in the pattern shop, regardless of whether the articles are classed as tools, stock or material, or whether they are those usually considered as finished goods or raw materials.

Securing Material.

If the foreman of the pattern shop desires some tool, fitting, or appliance, or special work upon material for his use which is to be made in the machine ship, forge shop or foundry, he should make application for the same to the order clerk, specifying the nature of the work and the order number to which it is to be charged. An order will then be issued, covering the desired work. The work thus performed and the material used will be charged to the order number by the foreman of the department to which it is directed. The finished work is then delivered to the foreman of the pattern shop, who receives it, but makes no entry on his order of the material or labor involved.

Rigid Rules.

It will avoid much confusion if all parties receiving and issuing orders are given to understand that all tools, material, or supplies should constructively, if not physically, pass through the store room or stores department, that is, that all articles, whether actually received and stored in the store room or lying in the lumber yard or storage shed, are under control of the storekeeper and are in his charge and under his control the same as if he had them on the shelves of his store room. He is responsible for their care and not a piece or pound of this material should be used without his knowledge or consent. For this reason a requisition should always be demanded for each individual order and it should specify the exact material wanted, the quantity desired, the use to which it is to be put, and the order number upon which it is to be used.

Pattern Shop Supplies.

It frequently happens that material is secured without a requisition and without the storekeeper's knowledge, so that it is almost impossible for the latter to accurately account for his stock and for the material for which he is responsible. In considering the question of supplies used in the pattern shop we will first discuss the material that may be classed under the head of pattern shop supplies.

REQUISITION FOR SUPPLIES

REQ. NO. _____ DATE _____

FOR THE _____ DEPT.

STORE KEEPER, PLEASE ISSUE THE FOLLOWING ARTICLES FOR USE IN THIS DEPARTMENT.

QUAN.	DIMENSIONS	DESCRIPTION	VALUE

TO APPLY ON ORDER NO. _____ _____ FOREMAN

ISSUED _____ RECEIVED THE ABOVE _____

The Foundry

FIG. 1—REQUISITION FOR MATERIAL AND SUPPLIES

Lumber.

Lumber ranks first, both in quantity and value. A large amount of the lumber used is white pine, although considerable cherry is worked up into small patterns and into such parts of patterns as require greater strength than pine possesses. The advent of the automobile has brought with it an increased demand for high grade patterns of light and thin construction and the necessity for considerable hand work in their formation. This requires a high grade material and for this reason considerable mahogany is used. All wood should be free from knots and should have a straight and parallel grain. All pine for pattern work must not necessarily be of first quality, as there is considerable work, principally on large patterns, where economy can be practiced without injury to the pattern itself, by the use of a cheaper grade of lumber. This should be of a fair quality and a large number of small knots will do no harm. It should, however, contain very little of the outer wood or sap, or small cracks called "shakes." If the wood has not been well seasoned, it will absorb and retain mosture and the alternate expansion and contraction will result in the warping and distortion of the pattern. Furthermore, the use of "shaky" wood, even if inside the pattern and

not in contact with the molding sand, is liable to prove very unsatisfactory. Under ordinary conditions only one grade of cherry, mahogany, or similar lumber is in use. Of pine lumber or its substitutes, it will prove economical to have three grades on hand. The second quality would not only answer for many parts of first class patterns, but many patterns of a temporary nature can be built entirely of this material. Third class lumber should be used as interior pieces, braces, frames, etc., which are to serve as supports for the outer shell of the pattern, which should be made of lumber of the first grade. By care and judgment in the purchase of lumber great economies can be effected.

ORDER

No._____ DATE_____

FOR_____

SHIP VIA_____

CUSTOMERS ORDER NO.	DATE OF ORDER	SHIPPING DATE	ESTIMATE NO.
REQUISITION NO.	DATE RECEIVED	PRICE	PROPOSAL NO.

TO THE_____ DEPT.

PLEASE DO THE WORK DESCRIBED BELOW AND HAVE IT COMPLETED BY

CHARGE ALL TIME TO THIS ORDER NUMBER.
CHARGE ALL MATERIAL USED ON THE BACK OF THIS ORDER.

The Foundry

FIG. 2—ORDER CARD FOR PATTERN WORK, SIZE 4 x 6 INCHES

MATERIAL ACCOUNT

ORDER No._____ DATE_____

MATERIAL	QUAN.	RATE	AMOUNT
LUMBER			
RAPPING PLATES			
DOWELS			
FILLETS			
PATT. LETTERS			
VARNISH			
TOTALS			

APPROVED

SUPT. FOREMAN

The Foundry

FIG. 3—MATERIAL ACCOUNT ON BACK OF ORDER CARD

Coating For Patterns.

The writer has never favored the use of wood alcohol for making shellac varnish for use on patterns. It has a low efficiency in protecting the pattern from the moist molding sand, has a short life as a protective coating, and its exceedingly unpleasant odor is sufficient to condemn it, notwithstanding the low price at which it can be secured. Denatured alcohol is to be preferred, and can be satisfactorily used in place of grain alcohol.

Orange shellac has a uniform clear color when held to the light and should be free from impurities. These may not be noticeable in the dry gum, but when a large jar full has been dissolved and used until little is left, considerable sediment is sometimes found. More or less of this will be worked out in the brush and it can be precipitated by the use of a small amount of oxalic acid dissolved in alcohol and stirred into the shellac after it is ready for use.

Pigments.

The dry colors used with shellac varnish to indicate core prints and the kind of metal from which the castings are to be made are lamp black, vermilion, ultramarine blue, burnt umber, chrome yellow and white lead. These pigments are sold by every paint dealer and little difficulty is usually experienced in securing a good quality, with the exception of vermilion and ultramarine blue, which are apt to be adulterated. They should always be dissolved in a small quantity of alcohol before they are added to the shellac varnish. The lamp black should be kept in a covered metallic can to avoid the danger of spontaneous combustion. For special shellac varnish a chisel pointed brush should be used. Brushes with the bristles set in soft rubber, which is then vulcanized, give excellent satisfaction. They are, however, not suitable for use in the glue pot, and for this purpose a brush with the bristles set in glue and bound with a cord or with tinned wire, will give satisfaction.

Glue.

The quality of glue should also be carefully considered by the purchaser. The color alone seldom determines its quality or adhesive properties. Its

strength can be determined by bending a piece slowly and noting how far it can be bent without breaking. An excellent quality of glue can frequently be bent to almost a half circle before breaking. It is usually not necessary to use a very quick setting glue for pattern work. Glue that sets too quickly is liable to result in poorly united joints. If for a special reason it is desirable to have the glue set quickly, the drying may be hastened by warming the parts to be joined.

Beeswax used for patterns should be of good quality, clear in color and free from adulterants. Adulterated wax is difficult to apply and it frequently breaks off short when put through the wax press. The difference in price between good and pure wax is too small to make it worth while to suffer the annoyance of poor quality.

Fillets.

The respective merits of wood and leather fillets have been much discussed. Both should be on hand in the pattern shop and should be used according to the shape of the casting. For straight work the wood fillet can be quickly applied, but for curved work the leather fillet is better adapted. The thin edges of wood fillets are easily damaged and great care should be exercised in storing and handling them. They should not be stored in a horizontal position, but in a rack in which they can be held in a vertical position.

Pattern Letters.

Pattern letters and figures of the sizes and styles in common use should constantly be kept in stock. For a great many purposes they can be affixed to the patterns with shellac. Ordinary letters and figures can frequently be made in the pattern shop. A hinged mold may be made of brass, the pattern for which is made of plaster of Paris, poured over an enclosed flat surface upon which the set of the letters or figures have been fixed with shellac. The brass casting is then finished on its face and a similar casting with a plain surface is hinged to it at one end, the other end being fitted with handles. For the purpose of permanently fixing these letters and figures to the patterns, two conical points may be cast on the back, the holes being drilled in the plain portion of the brass mold. The molds are always heated before the metal is poured into them. The alloy used for this purpose usually consists of lead and antimony.

Rapping Plates.

Malleable iron rapping plates should always be on hand in sizes suitable for all the patterns that are likely to be made. They are very strong and frequently add to the strength of the pattern to which they are attached. They can be easily fitted and are cheaper than wrought iron plates made by the blacksmith and which are drilled, countersunk and tapped in the machine shop.

Dowel Pins.

Brass dowel pins should be used for all small and medium sizes of wood patterns and a large assortment should be kept on hand for all classes of patterns usually made in the shop. Pins driven into a single hole should be used for small patterns while those secured by screws and formed with a plate should be used on larger work. For very large patterns, malleable iron dowel pins will prove very serviceable. Wood dowel pins should only be used on patterns intended for temporary or occasional use.

Wood screws for use in patterns are frequently ordered of too large a diameter for the length. A comparatively small screw will answer for ordinary purposes and does not cut away as much of the strength of the wood, particularly on a narrow piece, and we have never seen one broken from the strain of holding the parts in place. A No. 12 is large enough for a 2-inch or a 2¼-inch screw and a like proportion should be carried through the other sizes. The use of large clumsy screws is more in keeping with the work of the carpenter than that of the patternmaker. What has just been said of wood screws will apply with equal force to wire nails or brads.

Tools and Appliances.

There are various tools and appliances that can be either ordered from time to time or kept in stock in the store room. These are not considered a portion of the patternmaker's kit, which he is expected to furnish himself. Among these are included wooden clamps or hand screws, malleable iron clamps, rules over 24 inches, and other tools which are too large for the chest or are required by the special nature of the work. Lathe tools should also be furnished by the concern—and can handily be made in the forge shop as required. Steel stamping letters and figures should be furnished by the company and of such sizes as the pattern shop foreman may designate. Usually, one set of letters will answer, ⅛, ¼ and ½-inch, and one set of figures of each size as follows: One-eighth, ¼, ½ and ¾-inch. The ⅛ and ¼-inch sizes should be made of steel, but the larger sizes, being used on wood only, can be made of cast iron.

As previously stated, the tools, stock and material of whatever kind and wherever located, are in charge of the storekeeper and should not be withdrawn except on an authorized requisition. Ordinary material for use on any job, such as lumber, gum shellac, alcohol, beeswax, etc., should only be charged to some definite order after they have been used and should be issued solely on the authority of the foreman of the pattern shop. He can give an order for material for general use, and later, all the material used should be charged to definite orders and this distribution should be made as equitably as possible.

Method of Charging Supplies.

Some concerns charge supplies of a general character to the general expense account, and in this way they become a part of the overhead burden of the entire plant. Where the work of the pattern shop is confined to patterns for sole use by the concern this method may save considerable clerical work and may not prove particularly unjust. On the other hand, if considerable work is done for outside concerns it is manifestly proper that each order should bear directly its proper proportion of this expense. It should also be noted that when any of these articles are required for pattern shop work use, a requisition should be made on the storekeeper, even though the foreman of the pattern shop knows that the storekeeper does not carry any in stock. The storekeeper then makes a requisition on the purchasing department for this material.

When the articles have been secured, the receiving clerk delivers them not to the foreman of the pattern shop, but to the storekeeper, that he may account for their receipt and delivery to the pattern shop. However, as a matter of convenience and economy in handling material the storekeeper may authorize the receiving clerk upon the receipt of a certain shipment to hold it until he has checked it and then deliver it to the pattern shop. In this case it is said to have constructively passed through the store room. This method is usually followed in handling pattern lumber, for the reason that it is not only more convenient, but furthermore, owing to the fact that the storekeeper has no suitable place in which the pattern lumber can be stored.

Storing Pattern Shop Material.

Alcohol, gum shellac, glue, beeswax, and varnish and glue brushes, wire nails, wood screws and similar ar-

ticles should be kept in stock in the store room and issued to the pattern shop as required. Malleable iron clamps should also be kept in stock, as they are frequently issued to the different departments of the machine shop. The reason for keeping these articles in the store room rather than the pattern shop is that from considerations of economy they should be purchased in such quantities as would be inconvenient to store and properly care for in the pattern shop.

Such articles as rapping plates, brass, malleable iron and wooden dowel pins, pattern letters and figures, dry pigments, etc., should be purchased in the quantities specified by the requisition of the pattern shop foreman and issued to him when received from the receiving clerk. These articles are usually purchased in comparatively small quantities and as they are used only in the pattern shop they can be easily stored and cared for in that department. Wooden clamps, steel, stamped letters and figures, pattern letters and figures, and similar supplies should be purchased only when called for by the foreman of the pattern shop and should be delivered to him from the store room when received.

Requisition Order.

A good form for the requisition of tools, stock and material is shown in Fig. 1. For convenience in filing this card is 3 x 5 inches in size. By the use of a carbon, the filling out of the blank on the paper makes a copy on the card, which is sent to the storekeeper, while the original sheet is kept on file in the pattern shop. This blank is headed with the date and serial requisition number, as well as the department by which it is issued. Spaces are also provided for stating the quantity of the article desired, the dimensions, etc. This card should be signed by the foreman. When the articles are issued by the storekeeper their value is entered in the column at the right. Usually, only one lot will be called for on one requisition, although if several articles are of the same class and are to be used upon the same order number or for the same general purpose they may be entered upon the requisition.

It frequently happens that the delivery of articles is delayed because they have not been fully described in a requisition. Storekeepers are frequently compelled to return requisitions several times before a correct description of the goods required is obtained. For instance, an order for two gross, ½-inch wood screws might seem all right, but it is not definite enough. What is the diameter? is the question then asked and other information should be given regarding the kind of head and whether they are flat or round.

Shop Order.

When the storekeeper has issued articles on the requisition shown in Fig. 1, properly filled in the date of issue, the value, etc., and has made the proper entry on his own records, the complete requisition is sent to the cost clerk. Before doing any work or issuing requisitions for stock or material on an order, it is assumed that the foreman has received a written order for that work. A form for such an order is shown in Fig. 2. This gives the serial number and date on which it is written, followed by the name of the customer and shipping directions. This is followed by the name of the customer's order and the date when received in the shop, shipping date, the numbers of the requisition, estimate, etc. A space is also allowed in which to note the price when it is desirable to do so. The name of the department to which the order is sent is next given and the date upon which the work should be completed in case a date has been set. Space is also allowed for a description of the work. This order card is 4 x 6 inches. It is a carbon copy, the original of which is usually written by the order clerk.

Form for Material Used.

On the back of this card is printed a form for the amount of material used, as shown in Fig. 3. The order number and date are inserted on this card for convenient reference. Under the head of material a sufficient number of spaces are allowed for the various articles used on the order and their value. The quantity column is always filled in by the pattern shop foreman and he usually fills in the rate column, but leaves the last column for the cost clerk, who also makes up such totals as are necessary. The time consumed in filling the order is made up on time cards, preferably by the jobbing time card method, with the time of commencing and completing the order, stamped by a recording clerk. When the work has been completed and the foreman has made up the material account, he signs it and sends it to the foreman for approval. After examination, if approved, the card is sent to the cost clerk.

PRODUCTION OF PUMP CASTINGS

BY WM. ROXBURGH

THE importance of sound pump castings no one can overestimate, and the molder who clearly understands the life and property therein involved, is doing no more than his duty, to see that nothing sham or shoddy shall pass from the foundry. Thus, it is that many engineers have their conservatisms in their particular founder for pumps. Some may say that it is mere cant to talk so, as the specified tests of pounds per square inch bring all founders to the same level. This is only partially true, for while a pump may be entirely satisfactory on this, and its exterior so far as inspection goes, be first class, still beyond all this there are other conditions to be mastered, which, without a due understanding, militates against the life of the pump, with the result that its greatest working capacity is at a minimum of duty, when its greatest capacity should have been possible at its maximum of duty. Further, the casting of pumps brings out the true value of a man regarding his knowledge of the uses and adaptation of the different brands of pig metal in the foundry. Some have their stereotyped pump mixture of hematite, gray and scrap iron of ordinary qualities, and regard this as a panacea for all the ills that afflict this class of work, and many a good foreman has been thrown off his guard by mixing according to specification. There is nothing wrong in customers specifying what they want, provided they take supreme responsibility, at least when their casting is under hydrostatic pressure, but if not, all the buyer has a right to ask for in this respect, is, that his casting shall be sound and perfect in every way while being hydraulically tested.

It would not be interesting to many of your readers, to spin a treatise on how a pump mold should be made, further than to say that what this short article contains refers to pumps of any size from two to 12 tons or more in weight, the latter being

the heavier metal will as likely as not give most trouble while being tested. While not taking up much time with the mold we cannot get a proper understanding of our subject without touching on one or two of the points which are so essential to the success of casting pumps.

We will take for granted that the mold is complete and in every way gated so as to run in due time, and that the metal has flowed into every nook and crevice, valve seats, etc., so that when bored or machined all will be sound and perfect, and that coldshuts are secured against by using the right mixture of metal and casting at the proper temperature, a strict observance of these two points being of the greatest value as we may see further on.

As the inside of a pump casting is very much what the cores make it, it is of much importance to see that as little broken skin as possible be made by the jointing of cores—a necessary evil too common with many of the larger sizes of pump castings. Indeed, where the inside of a pump is made by one complete core, results are at all times more satisfactory, but this being seldom a matter of choice, and as the matching of cores necessitates the use of chaplets in a more extensive way than otherwise, strive to use the fewest possible, and also the greatest minimum of fins between the jointing of cores. These two factors may seem trifles to many, but an indiscriminate use of the former, and an injudicious or careless method of the latter is, to say the least, not good for the casting, as both intensify the risk of sweating while being tested.

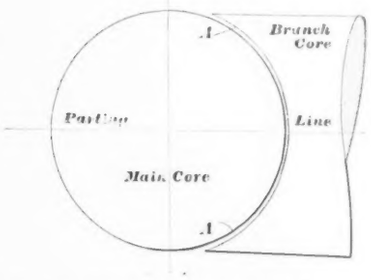


FIG. 1—POPULAR METHOD OF CLIPPING CORES

Figs. 1 and 2 illustrate two ways of "clipping" cores. Fig 1 is the most popular, but is not good, as the clearance shown at AA, Fig. 1, creates nasty fins that have to be chipped off, consequently affecting this part of the casting; the less broken skin there is about a casting the better, and especially is this the case with castings that have to be tested hydraulically.

In a word, if the foregoing be observed with intelligence, the danger of sweating will be minimized and the growth of internal corrosion in such castings will be reduced to the lowest possible, which in turn gives the longest working capacity to a pump casting.

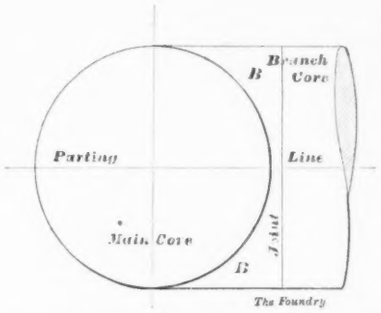


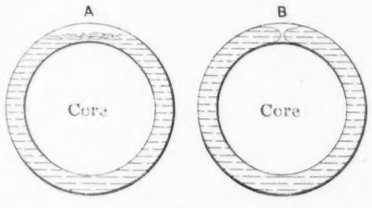
FIG. 2—PROPER METHOD OF CLIPPING CORES

Fig. 2 obviates this trouble to a very great extent, and in every way improves the casting, besides the chances of a mishap in the foundry through the "clips" being broken while coring, or washed away while pouring, thus both dangers are absolutely removed jointing the cores, as seen in Fig. 2. In this illustration it will be observed that BB constitute the "clips," these are rammed up on the main core by the aid of a saddle box which may either be of skeleton or complete form, finished and dried along with the main core, and if ordinary care be taken with the face of the branch core (see Fig. 2) to see that it fits into part BB of the main core, the amount of fin accompanying this method of dealing with branch cores, is trifling indeed. Hence, Fig. 2 as illustrated is the ideal *modus operandi* for working branch cores which have to be built against round, spherical, or square faces, and the larger or greater the diameters or surfaces may be, the advantages become the more manifest in every conceivable way, and for cheapness of production it has no equal where "clipping" and jointing of cores are a necessity.

Although the metal for casting pumps has already been referred to in a way, we again emphasize the fact that it is not so much from a tentional, tortional, or transverse test of metal we must judge alone, for while these points may be paramount with many castings, it is not so with pumps, to the neglect of fluidity.

The margin of thicknesses given is usually safe, and when failure does occur it is generally to be found in something else than the want of metal, that is to say, if the thicknesses are proportioned and manipulated with intelligence of practice. This being so it follows that while a superior and probably costlier iron may be quite serviceable for many castings the same may not be suitable for pumps of elaborate or complex design, and further, because of the necessity there is to guard against using a metal that inclines toward rapid oxidation, with its consequent excess of shrinkage. Oxide laden metals are at all times mischievous, and nowhere is this exemplified with greater emphasis than in the casting of pumps. As with valve seats that have to be faced and bored, variety of thicknesses of metal in the same casting, and if cast at a temperature suitable for the heavier parts, danger from coldshut with this metal passing upwards, perhaps, to lessen space of mold, becomes intensified at those extremities through the oxide laden metal refusing to fuse, thus creating a faulty casting, which is more than likely to remain concealed until such time that the hydraulic test reveals this incurable mistake, so suggestively named "coldshut."

Figs. 3 and 4 give the contrast between fluidity and fusion, coldshut and non-fusion. Fig. 3 shows what is wanted, Fig. 4 that which must be avoided. It will be noticed that the former of these figures represents the metal as having passed quite fluidly over the highest part of the core A, while Fig. 4 represents the metal sluggishly meeting, but, the oxide surfaces as seen at B are compelled to meet, yet never fuse, and if we accept the inside and outside skin of the metal, which is never thicker than a piece of silk paper, homogeneity or assimilation of fluidity at those points are absolutely nil, and spell irretrievable loss for all castings that are to be hydraulically tested.



FIGS. 3 AND 4—PROPER AND IMPROPER FLOW OF METAL AROUND CORES

Again, valve seats of such castings

as a rule, are more or less disproportionate in metal, and as a result produce irregular and erratic movements of shrinkage. Such behavior is damaging to the best metal ever produced in the casting of pumps. Hence it is that what many consider to be the best metal, and which by the way is not always the cheapest, has failed when tested by others. Therefore, if there be no practical knowledge in the adaptation of metals as they relate to the production of castings and their several wants, the analysis of this, that or the other metal availeth nothing. No not even a knowledge of the eutec

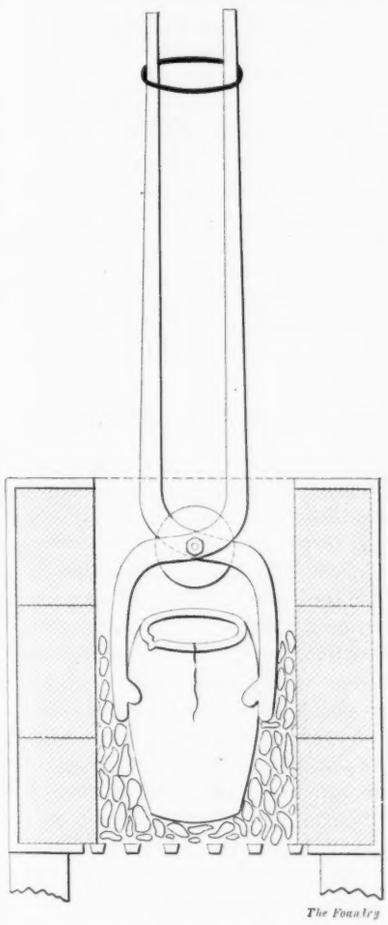


FIG. 1—TONGS WHICH EASILY CRUSH THE CRUCIBLE

ties which are first to fuse, and last to freeze, or a mastery of all that is in the gamut of the chemistry of cast iron, means but little if not coupled with cause and effect producable through the three transitions, first from the fluid to the plastic, second, from the plastic to cherry red solidification, and third, from this transition to absolute shrinkage, and the subsequent treatment of slackening to facilitate shrinkage when necessary.

Thus we summarize the knowledge necessary for using metal in the foundry, as, "mixing," "adaptation," "temperature," "feeding when necessary," and "slackening" to facilitate shrinkage, "position of casting," "location of impurities," "design," "camber" in bedding down, etc. These, to-

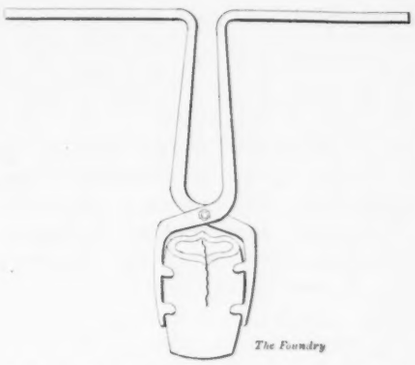


FIG. 2—TONGS USED IN GERMAN BRASS FOUNDRIES

gether with the power to grasp the phenomena warped through the continuity of the three transitions of shrinkage as previously referred to, mean much in the success of casting pumps, and other castings of complex design, large or small, cast in steel, brass, or iron.

THE CARE OF CRUCIBLES IN THE BRASS FOUNDRY.

BY EMIL B. HORNE

With proper care, the life of the average crucible used in brass foundries can be greatly lengthened. A new, cold crucible should never be

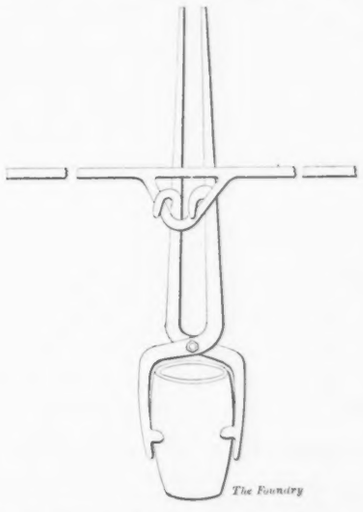
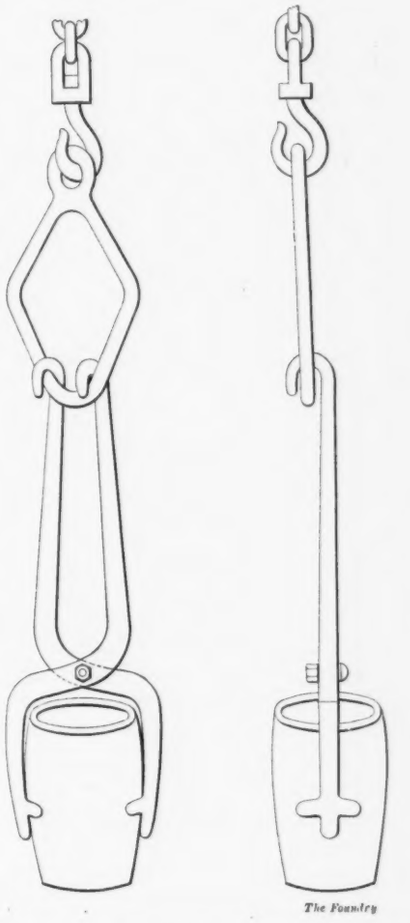


FIG. 3—TONGS SHOWN IN FIGS. 4 AND 5 ADAPTED FOR USE IN SMALL FOUNDRIES

placed in the furnace immediately after it has been received. It should be stored in a dry, warm place for at least two weeks before it is used, the top of the core oven being ideal for storage purposes.

The lifting of the crucibles out of the furnace is another factor that affects the number of heats that can be safely made. The tongs shown in Fig. 1 are properly styled "crucible crushers." A crucible in which 8 or 10 heats have been made does not require much force to crush it. The long arms on the tongs when pressed together sufficiently to slip over the ring exert a great force and crucibles are frequently flattened in this way.

The tongs shown in Fig. 2 are not much better and are used almost exclusively in Germany.



FIGS. 4 AND 5—TONGS PROPERLY DESIGNED WHICH DO NOT CRUSH THE CRUCIBLE

A pair of tongs and a catching device are shown in Fig. 4, with which any crucible can be pulled without crushing. The pot is gripped a few inches below the center, and the fuel must be pushed aside to insure a firm hold. By the use of the tongs shown in Figs. 1 and 2, the crucible is frequently only held at the top and the pot is easily crushed in this way. The tongs shown in Figs. 4 and 5 are used in connection with hoists, while the arrangement shown in Fig. 3 is adapted for small foundries having no hoisting arrangement.

PRODUCTION OF MALLEABLE CASTINGS-VIII

A comprehensive discussion of the various melting processes including a comparison of the converter and air furnace

BY RICHARD MOLDENKE

TAKING next the Bessemer converter process for making malleable castings, we find this a rather new line, and so far only used in some parts of Europe, where the fracture of an annealed malleable casting is similar to that of steel. The quantities blown at a time are very small, say half a ton to three tons, and the process is no different from the ordinary baby Bessemer process now used, except that it is stopped before the silicon gets too low. In other words, it is necessary to first melt the charge in the cupola, run the molten mass into the converter, blow until the silicon has been estimated to have dropped low enough. Then a sufficient quantity of aluminum is added to insure sound castings, and the metal is poured.

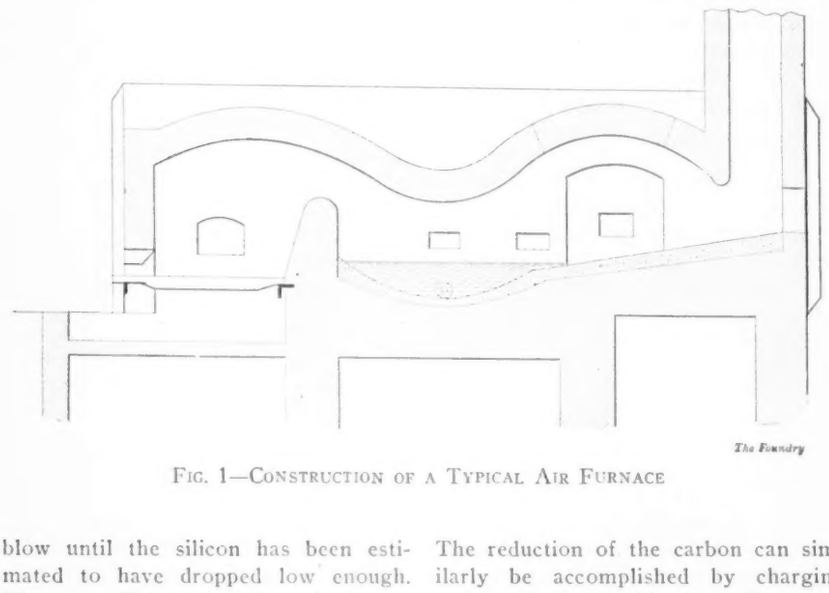


FIG. 1—CONSTRUCTION OF A TYPICAL AIR FURNACE

The Converter Process.

The advantages of the process would seem problematical to American minds, as there is nothing in it which cannot be done by the ordinary cupola process. It emanates from the mistaken idea that it is necessary to refine the metal to make good malleable castings. This is not the case, as the burning out of silicon, manganese, and perhaps a little carbon, which takes place in any of the processes for making "malleable," is that which is unavoidable in the melting and the raising of the metal to the proper pouring temperature. In other words, if it were possible to simply melt without changing the composition whatever, the ideal melting condition would be obtained, as any strength gained by the reduction of the silicon and the carbon can be more easily and better obtained by charging steel scrap in the mixture. Hence, in discussing the Bessemer process for making these castings, the reduction of silicon is not necessary except to get heat, and this can be attended to in the cupola just as well. The reduction of the carbon can similarly be accomplished by charging steel, and any trouble that follows can be corrected by adding aluminum in the ladle, just as has to be done with the converter. The advantages do not therefore seem to be manifest.

Disadvantages of the Converter Process.

Now as to the disadvantages. Melting a comparatively high silicon mixture in order to blow silicon out of it afterwards, means throwing money out of the window. The melting loss of the process, on account of the previous melting, cannot be less than 15 per cent, and may be much more. Aluminum is not a good thing to use on malleable work on account of its action on the carbon present. Large quantities throw out graphite easily, making a white casting gray and unfit to anneal. There must further be an uncertainty as to how much silicon is blown out before the process is stopped, and finally the tendency to burn the metal is greatest on account of the direct introduction of oxygen into the metal, which should be avoided at all hazards.

Mention is made of the process at this time, because the number of baby Bessemer plants is slowly increasing in the United States, and there may be a temptation to use an existing plant for malleable as well as steel castings.

Air Furnace Process.

The air furnace process is probably the most important in use today, and will likely continue so, as its advantages are numerous, and the product excellent. Briefly summarized we have the following conditions:

The air furnace is comparatively cheap to build, and is easily maintained. Its operation does not require the skill as does the open-hearth furnace. The air furnace may be built in very small units, as low as three tons capacity, and still have a high efficiency. On the other hand, its size is only limited by the ability to get the metal away and poured before it deteriorates through being held in the furnace too long. The air furnace can be started up from a cold condition and make good iron. Successive heats can be made from it without renewing bottom. Air furnaces can be scattered about the shop as required, as no gas flues, extensive excavations, and charging platforms are necessary. The iron made is of the finest quality, if the furnace is run properly. The consumption of coal is fair, if fired right, and of good quality. The furnace is quickly cooled and easily repaired. It can be built by inexpensive workmen and kept in good shape cheaply, when compared with the open-hearth furnace. It requires no gas making plant, and can be

shut down indefinitely without abnormal deterioration.

Disadvantages of the Air Furnace.

The disadvantages may be summed up as follows: It takes at least an hour longer to run a heat in the air furnace, than it does for the same tonnage in the open-hearth, because the furnace is comparatively or altogether cold when charged. This has a bad effect on the metal. The coal consumption is greater than that of the open-hearth furnace. The form of the bath leaves a thin layer of iron near the stack, which is the metal coming out last. This metal is very often burned before it is poured into castings. On account of the longer time required to melt, and the difficulty of holding the metal long in the furnace after it is ready, the air furnace cannot be made as large as an open-hearth furnace, unless quality is to be sacrificed. The flame striking over the top of the bath, and in the melting actually cutting through the charge, necessarily imparts much of the sulphur from the coal to the metal. Iron with 0.05 per cent sulphur in the charge has frequently had the sulphur content increased to 0.34 per cent when the coal contained over 3.00 per cent sulphur. In the open-hearth this is not so noticeable.

Taking the advantages with the disadvantages, it will be seen that the air furnace is probably the best all around melting device that the ordinary plant can install. Hence it will be found in the great majority of American malleable casting foundries. It is only in the very large plants where malleable castings are contracted for by thousands of tons at a time, that the open-hearth furnace is essential, and further, an open-hearth plant should be used even by smaller concerns where the work is continuous throughout the year, day in, day out. Therefore, it is good practice to have both furnaces in a plant, the steady work going to the open-hearth, and the intermittent as well as lighter castings coming from the air furnace.

Construction of the Air Furnace.

Essentially, the air furnace is simply a covered basin of refractory material, into one end of which there is forced a big volume of flame, and the products of combustion are permitted to escape from the other end. It is in the design of this basin, the details of directing the flame, and the way this is made to do its work that the efficiency of the fuel used, depends.

English Type of Air Furnaces.

Fig. 1 is an illustration of a typical air furnace in outline. This is an English furnace, and is taken from "Modern Iron Foundry Practice" published by Van Nostrand. It is rather exaggerated in the contour of the roof, and presents a bad spot where the stack and furnace body come together, the brick at that point cutting away very rapidly. However, the bath is shown as well as the sloping bed, with the thin feather edge of metal toward the roof which is sure to be burned no matter how careful the furnace is run. The firing end, with bridge wall, grate, and ash pit, gives a fair idea of the form of an air furnace for malleable casting purposes. It will be seen that the roof slopes downward just behind the bridge wall, the heat to be deflected downward, and is very essential to a furnace of this type.

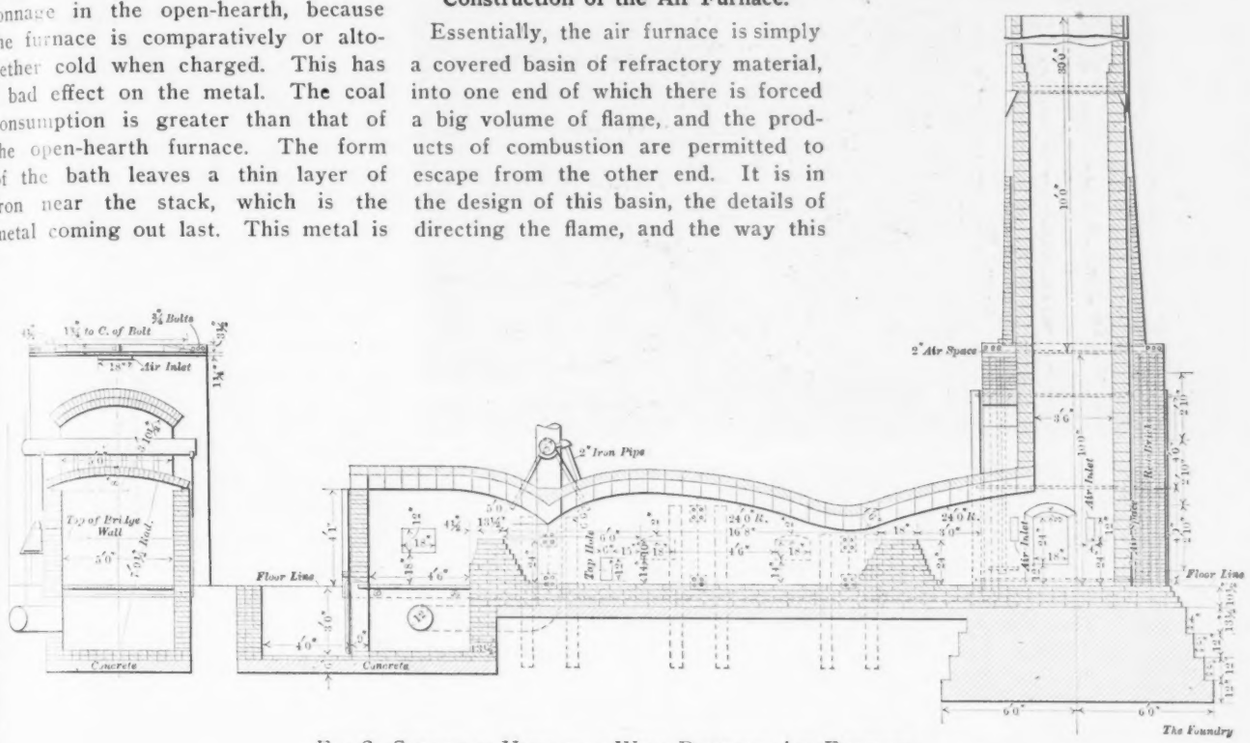


FIG. 2—SECTIONAL VIEW OF A WELL DESIGNED AIR FURNACE

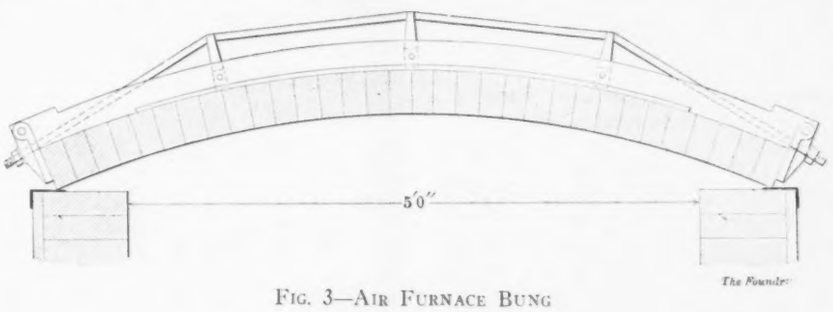


FIG. 3—AIR FURNACE BUNG

Well Designed Furnace.

Fig. 2 shows a sectional view of an air furnace of much better design, intention being to force the flames into the metal stacked up on the bottom, when melting begins. It is over this bridge wall, that the usual practice of placing air pipes exists. These pipes allow air to be blown into the flames, promoting more perfect combustion and sending the hot gases into the mass of metal below. The arching of the crown of the furnace allows the

FIG. 4—AIR FURNACE SHOWN IN FIG. 2, ERECTED IN THE PLANT OF THE MORSE IRON WORKS, ERIE, PA.

The sand bottom is not shown in the illustration, being put in after the furnace is built. This furnace plan was loaned by the Morse Iron Works, Erie, Pa., where the furnace is in successful operation. Fig. 3 shows a bung, a number of which go to make up the roof. Some of these are removed after every heat, to allow charging. The furnace in question has a length of 35 feet, and is 5 feet wide inside. The top blast in this instance has been placed a little distance away from the bridge wall, to get the greatest combustion directly over the tapping spout. Otherwise the furnace is typical of existing ones in practically all other plants. It also has two doors to facilitate charging, something which is not always found on other furnaces. Fig. 4 shows this furnace erected in the foundry.

Peculiar Arrangement of Tapping Spouts.

Fig. 5 shows another air furnace, at the works of Pratt & Letchworth, Buffalo, in which a peculiar arrangement of the tapping spouts is shown. These are on different levels, and allow the top iron, which is the hottest and most likely to burn, to be drawn off before the lower level of metal is tapped. In this way the capacity of a furnace can safely be increased without danger of burning the extra metal. This arrangement was designed by the author and applied by him at his works in Pittsburg, from whence it was adopted by others. In his own case, however, he employed three spouts at different levels, and thus got the same results as would be had with a tilting furnace, at a much lower first cost. This arrangement will be shown to better advantage later in discussing the open-hearth furnace.

Whiting Furnace.

Fig. 6 shows the general construction of a 10-ton air furnace, built by the Whiting Foundry Equipment Co., Harvey, Ill. Fig. 7 also shows an air furnace of 10 tons capacity, built by the S. R. Smythe Co., Pittsburg. Both of these are excellent furnaces, and give a high fuel efficiency and first class iron when handled properly.

In melting iron for making malleable castings, it should be remembered that as little refining as possible is desired. A short melt, making iron at the highest safe temperature for metal and furnace, is the *desideratum*. Refining, while reducing the silicon and getting added heat by this means, always results in oxidation, the effect of which has become more noticeable since the charcoal irons were abandoned, and coke irons substituted therefor. It is therefore better to use coal or gas for fuel than silicon, besides, it is less expensive. The additional strength obtained by refining as it was formerly carried on, is best obtained by changes in the mixture, as previously explained.

It is therefore necessary, in designing a furnace, to provide for an easy method of charging quickly; to get the most out of the fuel in the shortest space of time, even at the expense of efficiency, if necessary; and lastly, to tap out the metal in the shortest possible time.

Former Practice.

In the olden days of malleable practice, it was customary to take off the top bungs, charge, and when

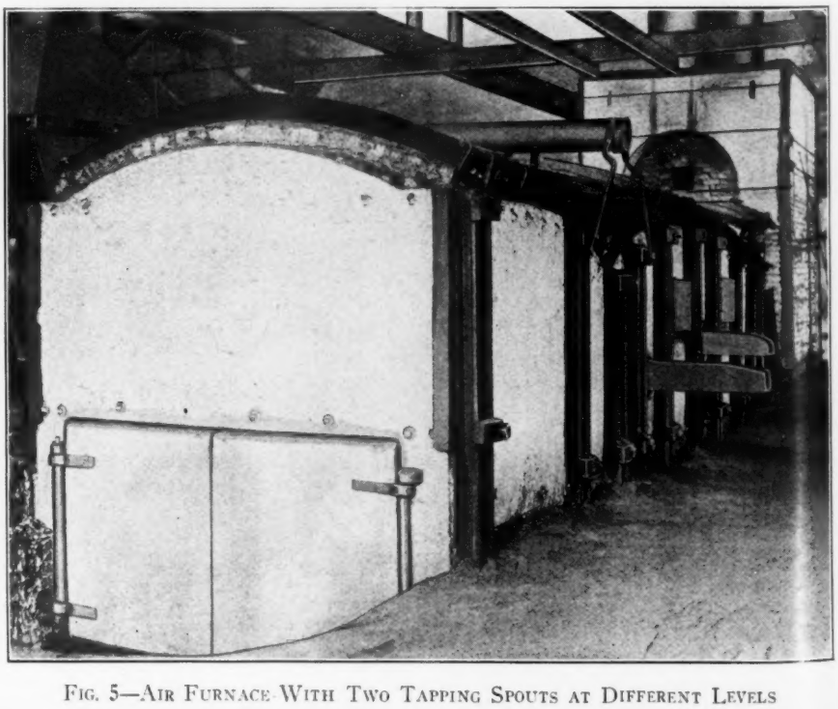


FIG. 5—AIR FURNACE WITH TWO TAPPING SPOUTS AT DIFFERENT LEVELS

ready to tap, have the molders catch their ladle full of metal at the spout, and then file up on a platform to pour it back into the bath. This heated their ladles, and did not waste any iron. This very praiseworthy method seems to have been abandoned at the present day, and unfortunately nothing takes its place. Rather elaborate experiments made by the author have demonstrated, that while the top and bottom of a bath of "malleable" usually have a composition so nearly alike that the difference may be classed as within the limits of error of the analyst (presupposing that the bath has been thoroughly rabbled by the metal taken from the very top of the bath showed white until the plate 1½ inches thick was broken from the one 2 inches thick. This metal was mottled. The casting made from the first ladle tapped on the other hand, had that particular heavy piece show a perfectly gray fracture.

When pouring, the same thing will happen, the first of the tap is undoubtedly colder than the top of the bath at that same instant, and hence much judgment must be used to pour the first iron into work which is fairly thin and will give the iron a white fracture. Spouts placed at different levels overcome much of this, taking away the hottest iron first, instead of the reverse.

Where the furnace ends and the stack begins, there should be a curve upward, allowing the gases to sweep into the stack without any sharp turn. This saves bricks and labor. Doors should be provided, so that the melter can rabble the heat thoroughly during the melt. For large furnaces, tap holes on both sides, and if necessary two of them on each side, will help to get the metal away faster. The philosophy of this will be seen from the fact that when a test plug is taken from the top, or at any rate from a point not very far down in the bath, and it indicates that the heat is ready to tap, it is oftentimes an hour or more, before that top metal actually gets out of the furnace. This should not be, for an hour's exposure of such hot metal to the gases passing over it, is sure to have a deleterious effect. Hence the importance of getting the iron out quickly.

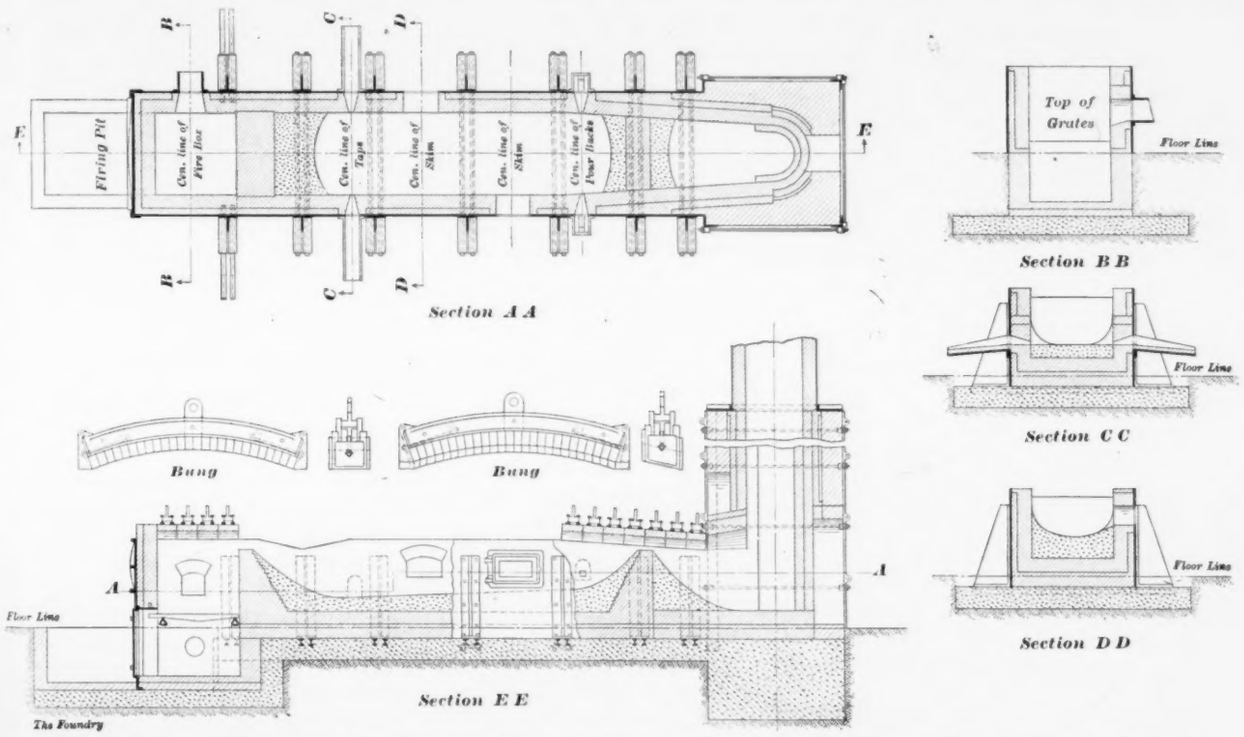


FIG. 6—TYPE OF AIR FURNACE BUILT BY THE WHITING FOUNDRY EQUIPMENT CO., HARVEY, ILL. CAPACITY, 10 TONS

melter throughout the heat), the temperature of bottom and top of this molten metal is by no means alike. This is best shown by the following test. The composition of the bath for silicon was 0.73 per cent at the top and 0.75 per cent at the bottom, where the metal was taken from the first ladle tapped, and was dipped out at the surface at practically the same instant. Molds were made with a pattern stepped up from a plate 2 x 2 inches and ⅛ inch thick, to similar plates ¾ inch, ½-inch, ¾-inch, 1 inch, 1½ inch and 2 inches thick. All plates connected to form one casting 2 x 14 inches with the thicknesses in steps. After the metal had set and cooled, the castings were taken out and the plates broken off one by one. The

Form of the Bath.

In designing an air furnace, the shape of the bath is important. The deepest portion is always put next to the bridge wall, and the bottom slopes upward to the throat of the furnace. In melting, this always leaves a thin or feather edge of metal where it is affected by the waste gases, and therefore badly burned. This may be avoided by cutting downward into the bottom, so as to leave the metal some two or three inches deep at the end. This, together with the covering of slag that usually remains there, effectively protects the metal from undue oxidation.

On the firing end, of course, it is necessary to have plenty of combustion space, grate bars through which blast can penetrate, clean ash pits, kept as cool as possible, and a clean and not too thick a fire. The great *desideratum* at the present time is the application of a stoker to the air furnace. Experiments so far conducted with the appliances have not materialized as they should, simply because the wrong type of stoker was tried. Once the firing can be reg-

ulated similar to a boiler there will be a different story to tell in some shops.

Charging.

In starting up a new air furnace, supposing the brick work to have been completed and the furnace dried out by fire, it is necessary to make a sand bottom. The best method is to apply layers of fire sand, with a little clay for the under layers, in thicknesses of 2 or 3 inches. Burn them in by firing. Keep this up until the top, where clean fire sand without clay is best. When charging, the sprues go in first, simply shoveled in and spread evenly on the bottom. The pig iron should go in next, and be nicely piled half at each end, not thrown in promiscuously. As the sprues melt and the piles of pig begin to melt, the man in charge can introduce his iron bar, and push down pig after pig into the central bath, thus keeping liquid iron there all the time. In this way all the pig iron is gradually melted, and the slag comes up readily to the top. Where the metal is thrown in haphazard, the whole pile melts down together, the melter cannot handle the charge to advantage, and the melting is prolonged possibly half an hour or more. Moreover the metal suffers accordingly.

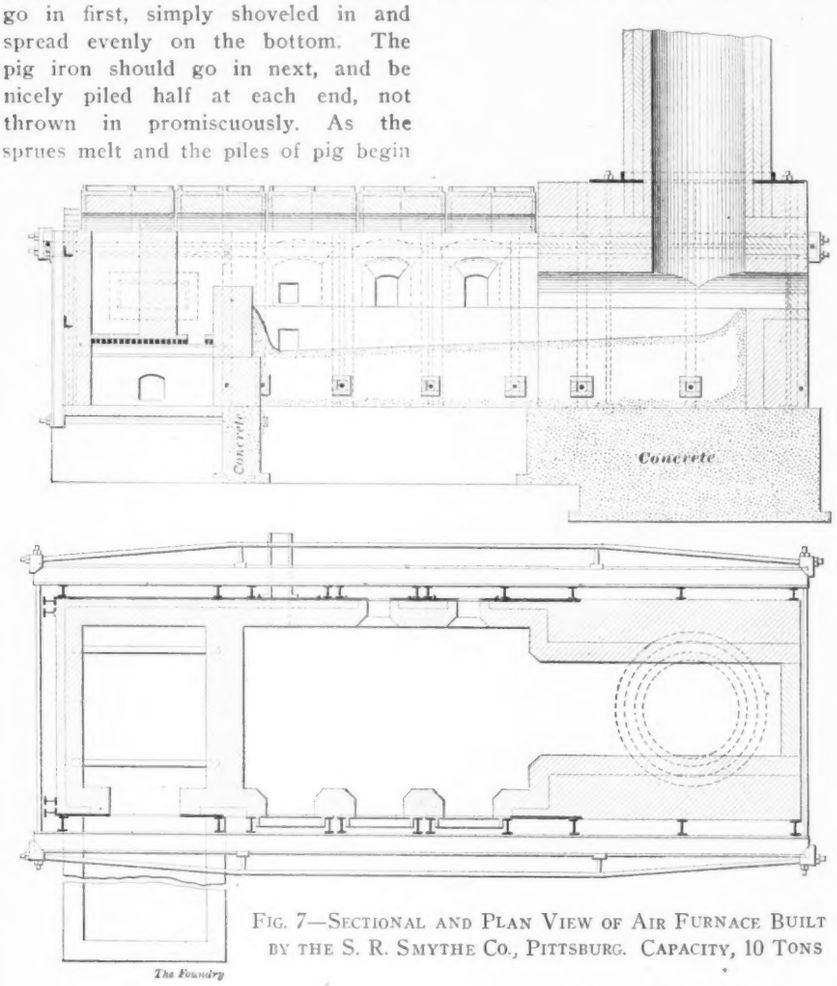


FIG. 7—SECTIONAL AND PLAN VIEW OF AIR FURNACE BUILT BY THE S. R. SMYTHE CO., PITTSBURG. CAPACITY, 10 TONS

Malleable scrap can be charged with the sprues, but steel scrap should be introduced after the charge is melted down, and a layer of slag collected on the bath. This prevents the steel from burning before melting down.

After the bath is liquid, and the slag is well up, this should be drawn off, and the metal given a chance to heat up. Usually it is necessary to skim again, and oftentimes a third time. Test plugs are taken from time to time as the heat nears completion and the character of the metal and its temperature judged from the appearance of the fracture. The diameter of this plug should be as large as any section found in the castings to be made. One and one-half inch is a usual diameter where the heavier class of castings are made. This plug, after setting, is held in water until cold enough to break without coloring the fracture. Then it is broken off, the extent or absence of mottling noticed, and the length of time still to be given the heat before tapping determined upon.

Use of the Test Plug.

Briefly it may be stated that such a test plug should show only a slight amount of mottling. The white crystals should be clear and large, the rim should not show pin holes, and the structure should not be mushy. If there is excessive mottling, the bath may be either too high in silicon, or the temperature not high enough. In that case continue the melting until a thin steel rod introduced in the bath and swished through the air throws off a shower of sparks, showing that the iron is good and hot. If the plug continues to show mottling, a little low silicon pig had better be thrown in. If the plug is clear white and thin castings are to be made, some high silicon pig, or ferro-silicon with say 20 per cent silicon, should be added and the heat well rabbled. This will bring out the heat as wanted. If the rim of the plug shows pin holes, the heat has been burned, and it is then up to the judgment of the man in command whether to add high silicon iron, and pig the heat, or to take chances. Probably the best way to judge is to pour some of the iron into molds. If it pours all right, and the ladles do not skull, the iron may be used, but if these symptoms appear, pig the heat. In any case where the test plug shows pin holes due to gas in the metal, no important work, or where pin holes in the casting cannot be tolerated, should be poured.

Melting Ratio.

In general, the efficiency of an air furnace should be four pounds of iron to one pound of coal, the latter to be of very good quality. The length of the heat would be somewhat as follows: For a 10-ton heat, after charging is complete, about four hours should see tapping commence.

The writer has known heats of that size to take from five to ten hours before they could be tapped. This is very bad practice, and though the castings may not have showed many surface defects, they were not up to strength as they should have been. Again, some furnaces only melt two pounds of iron to one of coal, instead of double that amount. This is a case of bad design or poor handling. The author has been told repeatedly, when making statements regarding the efficiency of air furnaces, that this high ratio is only obtained once in a while, but not regularly. The only answer that can be given is that a plant should be kept up to the point where this efficiency is always maintained. Some one should be held responsible for it as a simple matter of shop economy. It pays to keep everything about a malleable shop up to the highest standard, for when it begins to deteriorate, it does so very rapidly, and returned castings are bad things to have about.

CUPOLA CONSTRUCTION AND OPERATION*

Severe requirements and melting conditions of the modern gray iron furnace — Cupola operation and repairs

BY THOMAS D. WEST

IN years back, when one foundry was supposed to make almost everything from stove plate to an anvil block, the one arrangement of a cupola was made to generally answer all purposes. In other words, it was a jobbing cupola that was not pressed severely by competition.

Specialty Cupolas.

We have now in our different needs of melting with cupolas, conditions that call for:

1. A cupola that can be run steadily and continuously for a period of 12 to 144 hours, or all the week, day and night.

2. A cupola that can run at intervals of one to two hours, but continuous in not dropping its bottom for a period of from four to eight or more hours.

3. A cupola that can melt fair-sized heats of considerable very fine or dirty scrap alone, mixed with pig iron.

4. A cupola to melt steel scrap, tin scrap or sheet iron mixed with grades of casting scrap or pig iron.

5. A cupola that will burn out the lining the least.

6. A cupola for best speed in melting large heats for its capacity.

7. A cupola that can melt a large heat in the shortest time, or as fast as the metal can be taken away from it.

8. A cupola to be the most economical in its use of fuel.

9. A cupola requiring the least labor in cleaning it out and having droppings the freest of shot iron.

10. A cupola that can hold from two to ten or more tons before being tapped.

11. A cupola that can let its metals flow continuously.

12. A cupola that will give the best hot and clean iron.

13. A cupola that can best melt very large scrap or solid bodies of iron.

14. A cupola best to melt with coke or coal or having them mixed.

15. A cupola that can melt a large or medium heat slowly so its metal can be taken steadily from it by occasional taps during the lapse of five to nine hours.

All of the above 15 different features involve more or less of a blending of variations in construction and manipulation that make a very interesting study for the one that desires to comprehend the flexibility of cupola practice. In treating herein of the special points raised, the writer for want of space can only cite the main conditions involved, but which should be sufficient to place anyone at all conversant with founding on the right track of successfully attaining the desired ends.

While we have the 15 different features from which desired practices can be selected, it is to be said that a subdivision of cupolas into two classes, specialty and general cupolas, as is herein shown, should be capable of covering all the combinations that are generally needed.

Construction of Cupolas.

In taking up a brief description of the chief features and combinations required in constructing cupolas, we have first, referring to the foregoing numbers:

1. Those that must have the main tuyeres ranging from 3 to 4 feet above the bottom plate; a slag hole from 12 to 18 inches below the bottom of the tuyeres, and two or three rows of tuyeres. The cupola to have a height of 16 to 20 feet from its bottom plate to bottom of charging door or surface opening for admitting the stock, and not less than 60 inches inside diameter, the walls to be generally of a straight character.

2. Implies having a cupola so arranged that all openings below the charging door can be closed to make the admittance of air or draft impracticable at any point. Having a large breast that can be removed at the end of every interval in melting to admit of removing all iron droppings and dross or slag before banking to hold over the inclosed incandescent fuel from further burning until all is again ready to charge more fuel and iron and put on the blast. If a hot blast or warm air is used the better success in continuing such intervals of melting.

Tuyere Arrangement.

3. A cupola for this will also serve for No. 4, and is one that should have two rows of tuyeres, the bottom row being from 24 to 36 inches above the bottom plate and having a slag hole 10 to 14 inches below the bottom of the tuyeres. The cupola should be from 36 to 50 inches inside diameter, but if larger than 60 inches, a "center blast" would be found very advantageous. In height, such cupolas could range from 10 to 16 feet.

5. The best of all features for this is "center blast" alone or in combination without side tuyeres, when used in cupolas over 60 inches inside diameter. Without "center blast" it implies having the lining brought in at the lower tuyeres, and the same having large openings or areas. Upper tuyeres are not used in this cupola, reasons for which are stated later on. This cupola should also be sufficiently large in diameter so that no more than medium-sized heats for its capacity would be run and a mild blast used.

6. This cupola invariably calls for high tuyeres and a slag hole to be from 8 to 12 inches or more below the bottom of the tuyeres. It is best having upper tuyeres and must have a flux charged with its stock of fuel and iron to help form a fluid slag that can be run off between every tap after a cupola has been melting about 30 minutes. Blast pressure to range from 8 to 12 ounces and to pass through large area tuyeres. Cupolas under 50 inches inside diameter are best having a straight lining; over

*Read at a meeting of the New England Foundrymen's Association, Boston, Mass., Sept. 9, 1908.

60 inches the lining could be brought in or boshed or a center blast could be used.

7. This must be of a large size for its capacity. Have low tuyeres and no slag hole. The tuyeres should be of large area and it is all the better if there is an upper row. With cupolas over 40 inches inside diameter, the tuyeres may well be brought inward or boshed, or if over 60 inches a center blast is to be used. The blast pressure to range from 10 to 15 ounces. This is the character of a cupola most desired by shops having a large force of men and desire to pour off as soon as possible. Such cupolas cannot be expected to be the most economical in fuel, but if they can cut down the time of a large force, 15 minutes saved every heat pays for considerable loss in the use of fuel.

Large Cupola.

8. In considering this cupola, we have first of all to concede that whatever size is used, it will be run to near the limit of its capacity. This granted, we have but then to figure to obtain a high cupola having large area tuyeres brought in to work in connection with upper ones, and if over 60 inches inside diameter, to use a center blast in combination with the outside tuyeres. There must also be a slag hole 6 inches below the tuyeres and this is to be used after a cupola has run about one-third of its heat. The bottom row of tuyeres to be of fair area and to range from 18 to 24 inches in height from the bottom plate. Blast pressure 8 to 10 ounces. If this cupola cannot be run to its capacity, then lower the tuyeres 6 to 8 inches and dispense with the slag hole.

9. There are two plans that may be adopted for this work. The first is to utilize a cupola after the features embodied in No. 7. The second is to use a center blast, or fairly high large area tuyeres and in all cases where cupolas are to be run over one-half of their capacity to utilize a slag hole to its best efficiency. In no case should any cupola be run over the limit of its operating capacity in good order if a saving in cleaning and shot iron are objects for consideration above the other points.

10. An ordinary cupola, having a slag hole and the height of tuyeres to agree with the greatest amount of metal desired to be held before tapping.

11. This, as a rule, calls for the possession of a cupola larger than necessary for melting the size of the heat required, as in having a continuous flow the metal should come down in a stream of sufficient body to prevent obtaining a "dull iron." As a rule such cupolas could be worked with low tuyeres, which means greater economy in fuel than having high ones for short heats, and not require a slag hole. Upper tuyeres could be used here to increase the speed of melting, otherwise they can be omitted.

12. This demands large tuyeres areas and in large cupolas to have the tuyeres brought in all that is practical, or use a center blast in connection with the outside tuyeres. The bottom of the tuyeres should range from 12 to 16 inches above the bottom plate, and the fuel should be carried up to support the iron as high above the top of the tuyeres as a blast pressure of 10 to 12 ounces will carry it to best locate the melting point. If a cupola is to hold large bodies of metal before being tapped or to run long heats for its capacity, then it will be necessary to carry the tuyeres higher and use a slag hole. Upper tuyeres would also be found serviceable here as an aid to run long heats.

Medium Heats.

13. The ends are best served here for medium heats by having the lower tuyeres from 14 to 18 inches above the bottom plate. The tuyeres should be of medium areas, and the blast pressure range from 12 to 16 ounces. A good pressure is needed for such work, because of the wisdom of carrying a high bed to hold up the heavy iron from settling down to a dangerous proximity to the lower tuyeres. If the cupola is to run long heats for its capacity, then the tuyeres should range from 8 to 12 inches higher and have upper tuyeres, also a slag hole. The height of the cupola from its bottom plate to charging door to be of medium range. These cupolas are also best provided with a crane, or other appliances, whereby any very heavy bodies of iron can be lowered slowly to find a resting place on its bed or charge. The largest single piece of iron the writer knows of being melted in a cupola was a solid block weighing three tons. This was melted in a cupola 40 by 50 inches inside measurements, using all hard coal for fuel, by the Pratt & Whitney Co., Hartford, Conn.

14. In using coal, lower and smaller tuyeres are utilized than with coke. The rule for slag hole is the same with one as the other, only there is not as much slag as a rule coming from hard coal as with coke. Cupolas for coal can be less in height than for coke. Much slower melting may be expected with the former than the latter.

15. The conditions for this cupola are nearly the opposite exacted by No. 7. Here we require a small cupola for its capacity, one to have high and large tuyere areas, and a slag hole well below the tuyeres. If the cupola is over 50 inches inside diameter, then it is best to bring the tuyeres inward, or if over 60 inches to use a center blast. The blast pressure to range from 4 to 8 ounces, being regulated largely by the fluidity of the metal required. The "hotter" it is desired, the higher bed of fuel needed and hence higher pressure of blast. Upper tuyeres work well in this cupola.

Manipulation of Cupolas.

By larger tuyere areas we mean that one is to have all the openings for the admittance of blasts to the interior of the cupola to be about 25 per cent or one-fourth of the average area contained at the melting point. The minimum area for tuyere openings should not combined be less than 6 per cent of that contained in the area at the melting point. These latter small areas for tuyeres may in some cases do for melting with all hard coal, but for coke, large tuyeres are the best.

In reference to the use of upper tuyeres, it is to be understood that such create another melting zone. That means the additional burning out of the lining. It is chiefly in the case of running long heats for the capacity of a cupola, and where a slag hole is used or necessary, that upper tuyeres are most efficient. The disadvantages of the extra burning out of the lining, is often so serious, that whatever other advantages may be gained by their use have but little weight with many in continuing their use.

Function of Upper Tuyeres.

The function of upper tuyeres is to deliver needed oxygen to the escaping carbonic-oxide gases to thereby save a loss of heat. As far as this is concerned, the principle is correct and any who take advantage of it without being too seriously handicapped by the extra burning out of a lining, cannot but find upper tuyeres will save fuel and permit a cupola to run long heats with less "bunging up" than otherwise. It is generally best to have upper tuyeres built in a cupola, and when not found of advantage they

may be easily stopped up with valves and clay to prevent their being used or doing any damage to the lining.

Where reference is made to a slag hole, it is to be kept in mind that the greater distance there is between the slag hole and the under side of the bottom of the tuyeres, to the limit of such, the better for running long heats, or melting down fine or dirty stock. Having a slag hole implies the use of limestone or other flux to create a fluid slag and the running of the slag out of the slag hole.

The blast pressure given with the forms for construction is to be understood as for blowing cupolas when using coke. Where hard coal is used, the pressure will need to be from 4 to 8 ounces higher than with coke.

Although the writer has used center blasts most successfully for over six years, and strongly recommends it for general use in large cupolas, he does not expect many to adopt it on account of a fear that most all seem to have that it would cause them trouble.

Wherever a center blast is used in connection with outside tuyeres the lining of the cupola is to be kept straight, as the center blast makes it unnecessary to bring the outside tuyeres inward beyond the face of the lining to form a bosh.

One notable advantage of a center blast lies in permitting the use of a mild blast. The oxygen of the air and not pressure is what the fuel demands to cause combustion. We use pressure merely to force the oxygen in the air to reach the exterior and center bodies of fuel in our cupolas. The greater this pressure the more cooling and bunging-up effect it has on the body of stock facing the tuyeres when using cold blast. We can continue this cooling effect until a cupola is completely "bunged up." Could we but have a hot blast as convenient as a cold blast, many of the difficulties encountered by founders in having bunged tuyeres and bad melting would be obviated.

Anyone using or contemplating the purchase of a cupola, will find it essential to first learn what he wishes to achieve with it and then to see that it has a combination of the features that are best for the special conditions. After erecting a cupola a great deal depends upon its manipulation, but the best in this line will not overcome errors, in not possessing a combination of features which is essential for the special purpose for which the cupola is to be used.

WARPED OR DISTORTED CASTINGS---METHODS OF PREVENTION

BY JABEZ NALL

EVERYTHING considered, the life of a foundry foreman, like the policeman's, is not a happy one. His duties are innumerable and difficulties many, each day bringing a fresh batch of troubles to add to those of the day before. Some of these, when viewed in retrospect, it may seem could have been avoided, but to avoid them all he must be both omniscient and omnipresent. It is not our purpose to describe this angle of a foundryman's experience, but simply to refer to one phase of it that involves our subject to some extent. Many of his troubles, particularly as regards melting and cupola practice, in the jobbing foundry of medium size, can at least be set down to the fact that he must rely largely upon unskilled labor, and because his orders are not properly executed. Occasionally he may have an off-heat and its effect, traced through the various operations, may be responsible for the unexpected warping of certain castings. It may be that his troubles were the result of the off grading of his pig iron. In this case, one can be sure that the iron was too hard, and the machinist cannot be blamed if he sarcastically inquires if the castings were made out of pop bottles. The excessive shrinking of this iron will account for the warping of several castings that hitherto have behaved properly when made of a good grade of soft iron whose shrinkage was less than usual.

Prolific Source of Trouble.

This warping or distortion of castings is by no means the least of a foundryman's troubles, the causes for which are legion, and herein lies a prolific source of dispute between the molder, patternmaker and designer as to who is at fault and the best means of prevention and cure. There are certain underlying principles that govern the contraction of castings that should be familiar to all three, but unfortunately this does not always appear to be the case. There are many molders in the trade today who give little or no thought to the effect of contraction on the different thicknesses of metal in the casting they are making and of the means that may be employed to prevent undue strains on certain parts by special treatment, such as hard and soft ramming and accelerated or retarded cooling. If left uninstructed by their foreman they will neglect to put into practice the principles applicable to given conditions, which previous experience should have taught them was necessary, and they trust simply to luck, which is another word for carelessness. If this luck (so-called), however, should not favor them, they can always tell just how it happened, when the casting is defective.

The Patternmaker.

Then again the work of the patternmaker may be such that the molder has no choice but to take things as they are. The patternmaker, for instance, may say that as long as his patterns are true to the drawing his responsibility ends, but, if so, he loses sight of the fact that a true pattern is not the thing desired, but a true casting. It is possible, and sometimes is a fact that conditions arise such as this, that a design of casting with varying adjoining thicknesses of metal is unavoidable, yet by proper treatment in molding and cooling, this casting, though by its nature contracting in varying amounts and at different times, could yet be kept true to the design within the bounds of practice at least, if it were not for the fact that the pattern was so constructed that the parts requiring accelerated cooling were inaccessible. In such a case it is clearly up to the patternmaker either to camber his pattern a sufficient amount to take up the difference in contraction, or at least to have consulted with the molder before constructing his pattern and thus divide the responsibility. It may be that some suggested change in the design or metal distribution would meet with the approval of the designer and accomplish the desired end, but if

this is not permissible, some other means could be adopted.

The Draftsman.

The draftsman or designer is generally familiar with the principle of contraction, and the physical changes that take place in different sections of cast iron as they pass from a molten or red hot condition until they assume their ultimate shape; but among a multitude of other considerations, this point is not always given its full weight.

Occasionally, shapes are so designed that it is impossible to prevent warping and cracking during the process of cooling. It is difficult to get any exact data as to the amount of contraction that would take place in given sections of cast iron when cast together in one piece, because of conditions that cause tension or compression of the various parts, but it is a rule generally understood that the lighter sections will contract quicker and to a greater extent than the heavier ones.

Contraction Tests.

To test the amount of difference of contraction under free conditions, two pieces, one ½ x 4 inches and one 2 x 4 inches and 4 feet in length, were cast on edge in one flask at equal distances from the outer edges, separated about 6 inches at the center, that the heat of the one should not unduly affect the other. These were cast of metal suitable for high grade machinery castings, from one gate at the end as shown in Fig. 1, were left to cool in the flask without exposure and the difference in contraction noted. The lighter section contracted exactly ⅛-inch to the foot, or ½-inch in the total length, while the heavier section showed a contraction of exactly half that amount, or ¼-inch in the total length of 4 feet. This shows that in a length of 16 feet between these two sections, if connected at the ends, there would be a strain of 1-inch that must be taken up somewhere.

The heavy section was again cast singly of the same grade of iron and shaken out as soon as set and left exposed. This time it showed a contraction of 15-32-inch, or closely approximating the shrinkage of the light section in the first case. Thus we see that by retarding or accelerating the cooling of different parts of the same casting we may prevent undue and excessive strains by compelling the contraction to take place at the same time, and if so we can prevent very largely the warping or distortion of the casting.

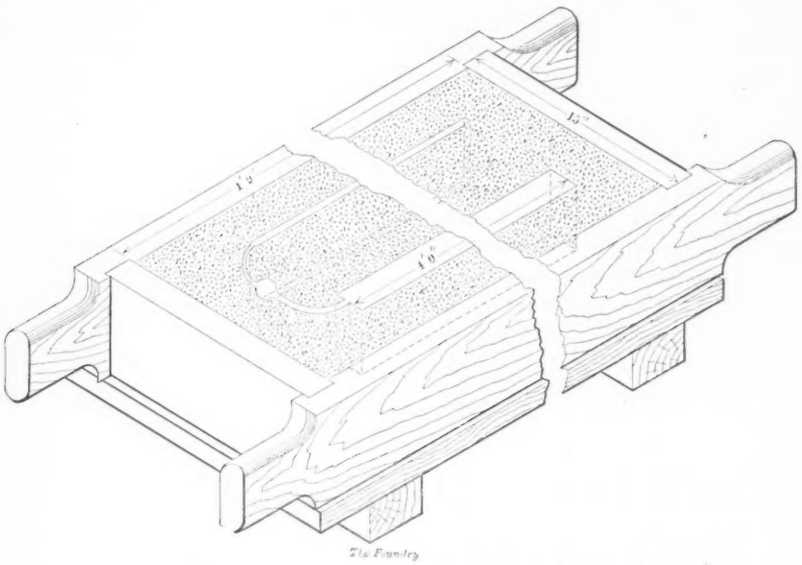


FIG. 1—METHOD OF MOLDING BARS FOR CONTRACTION TESTS

Difficulties With a Simple Casting.

Fig. 2 shows a part plan of a stair tread with a heavy molded nosing. It was impossible to prevent its warping as originally designed, shown in section at A, Fig. 2. Being cast with the diamond plate up it curled up at the ends. The lower edge of the nosing being thin cooled first, taking on its ultimate length before the contraction of the heavy metal commenced. This contraction later pulled this from the two ends, the action being similar to pulling a bow by drawing the string, the amount of deflection being governed by the rigidity of the bow and the strength of pull. In this case it amounted to about 1½ inches in 4 feet, making the tread unfit for use. The design was then changed as shown in the cross section at B, Fig. 2, and part of this metal cast on the riser, which permitted making the same lighter at the back, equalizing the metal thickness. After this was done there was no further trouble.

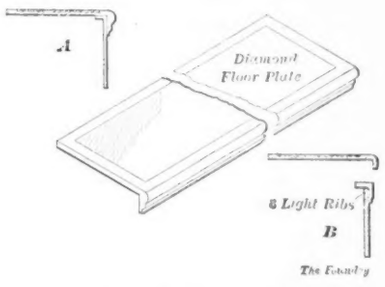


FIG. 2—DIAMOND PLATE STAIR TREAD

Diamond Floor Plate.

Fig. 3 gives us another example along this same line and shows a perspective view of part of a diamond floor plate 6 feet square, having strengthening ribs on the underside. This was cast with ribs down and the diamond impressions in the cope as before, with the result that the plate was dished from 2 to 2½ inches and it was impossible to control it by the usual methods of clamping and weighting the flask. In this, as in the former case, it was necessary to change the design to do away with the ribs on the plates and to build in extra supports in the structural framework to which to secure the plates which were then cast plain. These were successfully held straight by ramming the corners of the cope solid above the plate when the metal was set and weighting down above this to resist the tendency of the plate to rise, and it was left in that position until cold. By this means, plates were secured that would pass inspection and were practically straight.

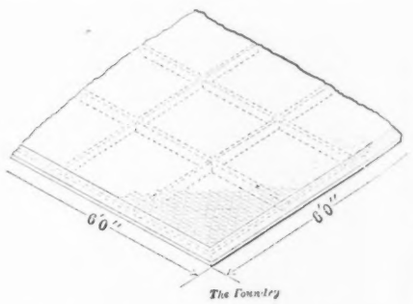


FIG. 3—LARGE DIAMOND FLOOR PLATE

Another Example.

Fig. 4 shows a semi-circular plate of 1-inch metal, having strengthening ribs ⅝ to ¾-inch thick, and a bolting flange along its straight side 1⅝-inches thick in the rough, with the outer edge reinforced for facing and bolting, of about the same thickness. This plate, cast with ribs down and left clamped until cold was found to warp upwards about ¾-inch, G, Fig. 5, being the highest points. The straight side of this plate being made of heavier metal remained straight, showing

that the strain equalized at this point. The warping of this plate was overcome by removing the cope and placing two straight rails upon the plate when set, as indicated in Fig. 5. These were weighted down sufficiently to resist the upward strain. The weights totaled about 4,000 pounds. This treatment successfully overcame the trouble in this case.

As like causes will produce like effects, the same conditions may be expected to produce the same results in the making of castings as in other lines of work. The special treatment of castings in cooling calls for intelligence, skill and experience of a high order on the part of the molder, and even at that it is uncertain of results. There are many shapes of castings that have a tendency to warp that can be more advantageously treated in the pattern by bending in the opposite direction to meet the strain. Experience and the design of the casting will determine how much this camber should be.

CASTING BRASS PUMPS.

By Chas. J. Goehringer

When purchasing a brass pump, a knowledge based upon long experience is advantageous. This especially applies when the device is to be used for pumping sulphuric acid, sulphurous acid gas, wine, whisky, mash, brine, mine water, etc., which have a great affinity for iron, producing a destructive affect, while copper and its alloys, although more costly, are to be preferred.

The various compositions or alloys used in brass and bronze pump ends, must be regulated by the chemical affinity of the metal to the various fluids to be pumped. I mention iron in this connection with a full understanding that there are different grades of this metal, some of which would, no doubt, resist the chemical action of acids or alkalies more readily than ordinary cast iron.

Frequently, orders for brass or bronze pumps are issued with the stipulation that they shall be cast according to the alloy prescribed by the purchaser, and a demand is made that the analysis conform to the prescribed mixture.

Brass or bronze pump molding is what is termed in the brass foundry as heavy work, and in many instances it is exceedingly complicated. In the casting of heavy work, composed of copper and tin alloys, the lower portion of the casting is liable to contain too much copper, while a corresponding excess of tin is found near the upper extremity.

To remedy this, a dexterous manipulation of the liquid metal is necessary before casting, that the alloy may be as nearly homogeneous as possible at the time of pouring. In the manufacture of new alloys, as a rule, it is necessary to melt the less fusible metal first, and to later add the more fusible metal.

The best results in this line of work are achieved with a course grade of sand. My reason for using an open sand is that it may be rammed hard, permitting the molten metal to rest on it with a greater degree of safety, than if a fine or close sand were employed. In this line of work, if the mold should not be rammed sufficiently, a swelling results, and, therefore, an unsightly casting is produced.

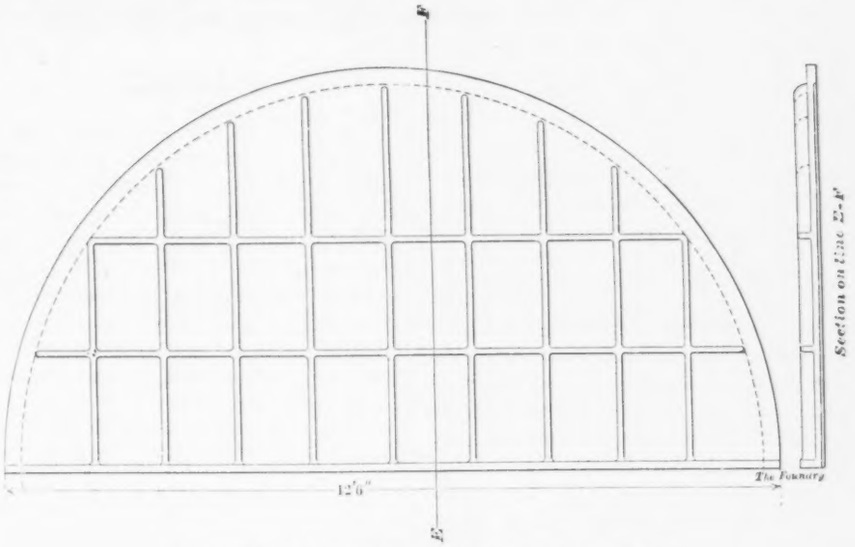


Fig. 4—Large Semi-Circular Plate, 1 Inch Thick

Another commendable feature connected with the use of open sand is that the gases produced during the pouring of the metal can easily escape, thereby greatly reducing the danger of a porous casting. Such an advantage is not to be obtained with close sand. A coat of wet black lead, well dried, produces an impenetrable surface, the body being longer retained, and permits the shaping out of the casting more readily than if the close sand were used. Sand that is used for facing purposes, should be as free as possible of all organic matter, otherwise gases are formed.

A good core is another essential feature in the production of a good casting. It should be of an open nature, and sufficiently hard to permit of free handling and should be properly vented. I have obtained the most satisfactory results by using cores not too warm, but of a mild temperature. Under no circumstances would I use a core of any great size, that had been exposed during the night to the cold atmosphere of the foundry.

Founders are generally of the opinion that if the metal of the first melt is run into ingots, and thereupon remelted, a better mixture is obtained. Excellent results are also received by the use of at least one-half of the remelt.

In conclusion I wish to state, that metal employed in this line of work should not be poured hot, but at a fair temperature so as to avoid segregation and porous castings.

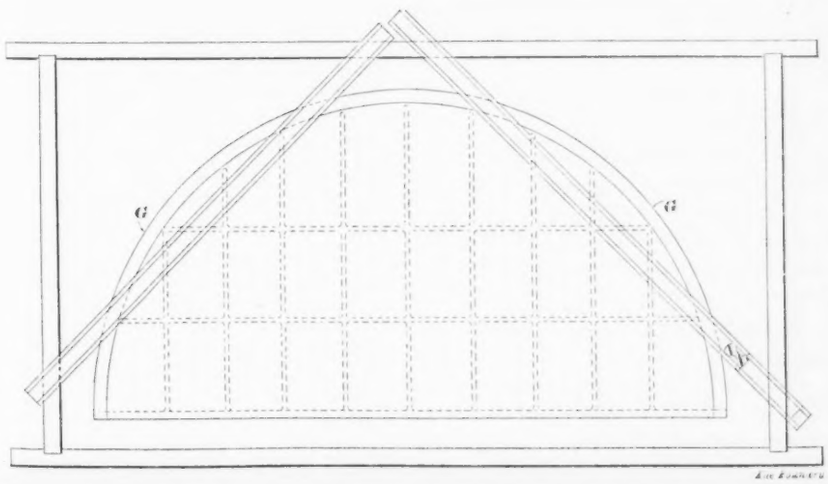


Fig. 5—Method of Preventing the Warping of the Large Plate Shown in Fig. 1

GRADING PIG IRON, ALLOYS AND COKE

Standard analyses of the various grades of foundry and steel making irons, ferro-alloys and melting fuels

THE following grading of pig iron, ferro-alloys and coke was prepared by Eliot A. Kebler, manager of sales of Matthew Addy & Co., Cincinnati, the foreign pig iron classification being furnished him by W. W. Hearne, the Philadelphia partner of the same company:

Standard Bessemer.

This iron is used principally for making acid Bessemer steel, this process burning out the impurities by blowing air through the molten Bessemer metal.

As neither this nor the acid open-hearth process removes any phosphorus, it must be low.

The standard specification is as follows:

	Per cent.
Silicon	1 to 2
Phosphorus	not over 0.10
Sulphur	not over 0.05

In the central section it is sold per ton, 2,268 pounds, if sand cast, or 2,240 pounds, if chill cast, except for special purposes, where the sand iron is broken, in which case it may be sold per ton, 2,240 pounds, and a charge of 25 cents per ton may be added for breaking.

In the east and west (Chicago) it is always sold per ton, 2,240 pounds.

Malleable Bessemer or Malleable.

This is used for the manufacture of malleable castings. The usual specification is:

	Per cent.
Phosphorus	not over 0.20
Sulphur	not over 0.05
Silicon as specified usually	0.75 to 1.25 or 1.25 to 1.75

Pigs are usually broken if sand cast, and both sand and chill cast are sold per ton, 2,240 pounds, except from a few furnaces in the central district which still sell some unbroken and also some broken malleable per ton, 2,268 pounds.

Low Phosphorus.

This is used for making acid steel extra low in phosphorus. The usual specification (sometimes called special low phosphorus) is:

	Per cent.
Silicon	1 to 2
Phosphorus	not over 0.035
Sulphur	not over 0.035

For baby Bessemer converters, the silicon is desired as high as possible. It is sold per ton, 2,240 pounds.

Washed Metal.

This is Bessemer iron from which a large part of the phosphorus and sulphur and practically all the silicon and manganese have been removed from the molten metal by one of the pig washing processes. It is largely used in acid open-hearth furnaces for steel castings and fire box steel, and also in making crucible steel. It is sold by analysis, the four analyses recognized being:

	Per cent.
Phosphorus	not over 0.010
Sulphur	not over 0.015
Phosphorus	not over 0.015
Sulphur	not over 0.020
Phosphorus	not over 0.020
Sulphur	not over 0.025
Phosphorus	not over 0.025
Sulphur	not over 0.030

It is cast on an iron plate, and comes in irregular pieces about 8 inches square. It is sold per ton, 2,240 pounds.

Basic.

This iron is used for making basic steel and can contain any phosphorus, as the basic flux and lining by combining with the phosphorus prevent it from entering the steel. As silicon attacks the lining and requires more flux, it is always specified under 1 per cent, and the basic pig is always sandless; that is, cast in chill molds. The sulphur is specified under 0.05. Basic iron is sold per ton, 2,240 pounds.

Iron Graded by Fracture.

This method of grading is being rapidly superseded by analysis grading.

No. 1 Foundry—Fracture contains large crystals.

No. 2 Foundry—This is considered the standard and contains medium size crystals, say ⅛ inch square, with no spot larger than 1 inch diameter without crystals, although pig can be close for ¼ inch along edges.

No. 3 Foundry—Contains small crystals; fracture is close.

East of Altoona, Pa., and throughout all of New York state these grades are: No. 1X, No. 2X, No. 2 Plain.

No. 1 is the highest priced, the usual differential being 50 cents a ton.

Forge has a gray fracture with practically no crystals.

Mottled shows small white spots, giving the fracture a mottled appearance. Most of the carbon is in the combined state.

White shows a white fracture, and all carbon is in the combined state.

These last two grades are usually high in sulphur and low in silicon.

In the south, iron which has a silvery fracture is graded as follows:

NO. 1 SOFT (sold same price as No. 1 foundry).
NO. 2 SOFT (sold same price as No. 2 foundry).
NO. 4 FOUNDRY (price is between No. 3 foundry and gray forge).

Foundry pigs cast in sand are always broken and all furnaces outside of a few of the central district irons are now sold per ton, 2,240 pounds. These few still sell 2,268 pounds to a ton, the extra 28 pounds being added to cover sand clinging to the pig.

Forge, Mottled and White iron may be unbroken or broken and is sold per ton, 2,240 pounds, with the exception of some central district irons, which are sold per ton, 2,268 pounds.

All pig iron cast in chills is sold by analysis per ton, 2,240 pounds.

American Foundry and Forge Iron by Analysis.

A committee appointed by the blast furnace interests has made the following classification by analysis, and the tendency is to sell iron by analysis instead of fracture.

SOUTHERN POINTS.

	Silicon, per cent.	Sulphur, per cent,
No. 1 foundry	2.75 to 3 25	0.05 and under
No. 2 foundry	2.25 to 2.75	0.05 and under
No. 3 foundry	1.75 to 2.25	0.06 and under
No. 4 foundry	1.25 to 2 00	0.065 and under
Gray forge	1.25 to 1.75	0.07 and up
No. 1 soft	3.00 and over	0.05 and under
No. 2 soft	2.50 to 3.25	0.05 and under

EASTERN POINTS.

	Silicon, per cent.	Sulphur, per cent.
No. 1X	2.75 and up	0.03 and under
No. 2X fdry.	2.25 to 2.75	0.045 and under
No. 2 plain	1.75 to 2.25	0.05 and under
No. 3 foundry	1.25 to 1.75	0.065 and under
No. 2 mill	1.25 and under	0.065 and under
Gray forge	1.50 and under	0.065 and up

Note—If sulphur is in excess of maximum, the iron is graded as lower grade, regardless of silicon.

CENTRAL WEST AND LAKE POINTS.

	Silicon, per cent.	Sulphur, per cent.
No. 1 foundry	2.25 to 2.75	0 05 and under
No. 2 foundry	1.75 to 2.25	0.05 and under
No. 3 foundry	1.75 and under	0.05 and under
Gray forge		0.05 and over

BUFFALO DISTRICT.

	Silicon, per cent.	Sulphur, per cent.
Scotch	3.00 and over	0.05 and under
No. 1 foundry	2.50 to 3.00	0.05 and under
No. 2 foundry	2.00 to 2.50	0.05 and under
No. 2 plain	1.50 to 2.00	0.05 and under
No. 3 foundry	1.50 (under)	0.05 and under
Gray forge		0.05 (over)

CHICAGO POINTS.

	Silicon, per cent.	Sulphur, per cent.
No. 1 foundry	2.25 to 2.50	0.02 to 0.05
No. 2 foundry	1.75 to 2.25	0.02 to 0.05
No. 3 foundry	1.35 to 1.75	0.06 and under
Scotch	2.50 to 3.00	0.05 and under
Silvery	3.00 to 3.50	0.05 and under
Gray forge		0.06 and over

Sampling.

The American Society for Testing Materials recommended the following method of sampling, which has been adopted by the American Foundrymen's Association:

In all contracts where pig iron is sold by chemical analysis each carload or its equivalent shall be considered as a unit. At least one pig shall be selected at random from each four tons of every carload, and so as to fairly represent it.

Drillings shall be taken so as to fairly represent the fracture surface of each pig, and the sample analyzed shall consist of an equal quantity of drillings from each pig, well mixed and ground before analysis.

In case of disagreement between buyer and seller, an independent analyst, to be mutually agreed upon, shall be engaged to sample and analyze the iron. In this event each pig shall be taken to represent every two tons.

The cost of this sampling and analysis shall be borne by the buyer if the shipment is proved up to specifications and by the seller if otherwise.

High Silicon Irons.

Softeners are sold by silicon contents and run from 6 to 10 per cent silicon, the price increasing about 50 cents per unit of silicon.

Silvery irons run from about 3½ to 5½ per cent of silicon. This last class is sometimes divided into No. 1 Silvery, which is the higher silicon, and No. 2 Silvery, the lower.

The still higher silicon irons are shown under ferro-alloys.

In addition to this, there is a special high silicon, usually 50 per cent silicon, although it is sometimes sold as high as 75 per cent silicon, made in an electric furnace.

Note.—No. 2 foundry and No. 2X foundry are the standards and No. 2 soft sells at the same price. No. 1 foundry or No. 1 soft sells usually 50c higher and "silvery" still higher, depending on silicon contents. The other grades decrease about 50c a grade.

"Scotch" indicates a more fluid iron, usually higher in phosphorus and silicon than the ordinary furnace run.

In selling by analysis the tendency is to do away with the numbers and merely give the limits in silicon and sulphur.

Ferro-Manganese—This is ordinarily sold with a guarantee of 80 per cent manganese, this being the only element which is guaranteed.

Owing to the lower phosphorus in English cokes, the English ferro-manganese ordinarily runs a little lower in phosphorus than that made in Germany.

Foreign Iron.

All pig iron is sold in England per ton, 2,240 pounds, and in France and Germany per 1,000 kilos.

In England and Europe generally iron is not called Bessemer, as both acid and basic Bessemer converters are used.

Hematite.

	Per cent.
Silicon	about 2.50
Sulphur usually	about 0.035
Phosphorus	usually 0.035
it seldom running	over 0.06

West Coast Hematite shows manganese under 0.50; East Coast Hematite has manganese over 0.75.

Thomas Gilchrist, or Thomas Pig Iron.

This is used in basic Bessemer converters and usually analyzes about:

	Per cent.
Silicon	0.50
Phosphorus	2.50
Manganese	2.50
Sulphur up to	0.20

Open-Hearth Basic.

There is practically no open-hearth basic in Europe or England. At Middlesboro the Bells are making open-hearth basic, but their pig analyzes:

	Per cent.
Silicon	0.75 to 1.50
Phosphorus	1.00 to 1.75
Sulphur	up to 0.20

They use a mixer and a desulphurizing bath.

English Foundry Iron.

This is graded by fracture and no analysis is guaranteed. The rules for standard foundry pig iron issued by the London Metal Exchange are as follows, and it will be noted that instead of grading by silicon contents, as in this country, sulphur seems to be the ruling element:

	Silicon, Per cent.	Phosphorus, not over, Per cent.	Sulphur, not over. Per cent.
No. 1, 2¼	to 3¼	1.00	0.04
No. 2, 2¼	to 3¼	1.25	0.05
No. 3, 1	Not over 3¼	1.65	0.08
No. 4, 1	Not over 3	1.75	0.10

The ordinary English Pig Irons can be divided into two groups, with

	Per cent.
Manganese	under 0.75
and Manganese	say 0.75 to 1.10

The brand and grade mostly imported into this country is:

Middlesboro No. 3. Analysis unguaranteed, but usually shows:

	Per cent.
Phosphorus	1.40 to 1.50
Manganese	0.40 to 0.75
Silicon usually	high, say 2.50
Sulphur	0.02 to 0.05

The No. 1 has practically the same analysis except that the sulphur is extremely low.

All Mine Pig Iron. Analysis about as follows:

	Per cent.
Phosphorus	0.20 to 0.70
Sulphur	0.06 to 0.20
Manganese	under 0.75

The Scotch Pig Iron is also sold by fracture, a typical analysis of No. 3 being

	Per cent.
Phosphorus	0.60 to 1.15
Manganese	1.10 to 1.80
Sulphur	about 0.03
Silicon	about 2 to 2.50

American Charcoal Irons.

These irons are divided into two classes:

Cold Blast, which is made in small furnaces with a capacity of about four to eight tons a day blown with unheated air.

Warm Blast, in which the blast is heated from 500 to 900 degrees Fahr.

Cold Blast Iron.

This iron is used principally for making chilled rolls and is graded as follows outside of the Lake Superior region:

No. 1, highest silicon, lowest sulphur iron with a fracture like a No. 3 coke iron.

No. 2 has a fracture like a forge and will chill ⅛ inch when cast against an iron plate.

No. 3 shows a ¼-inch chill.

No. 4 a ⅜-inch to ¾-inch chill.

No. 5 a ¾-inch to 1½-inch chill, the face of the pig being strongly mottled.

No. 6 is white, all of the carbon being in a combined state.

Warm Blast Iron.

This iron is used principally for car wheel work, for strengthening general machinery castings, and making rolls.

Outside of the Lake Superior region it is graded as follows:

No. 1 highest silicon, lowest sulphur iron, with a fracture like a No. 2 coke iron.

No. 2 has a fracture like a No. 3 coke iron.

No. 3 has a fracture similar to forge.

No. 4 will show a chill of about ¼ inch if cast against an iron plate.

No. 5, a chill of about ¼ inch to ¾ inch.

No. 6 will show a chill of about ¾ to 1½ inches and is mottled when cast in sand.

No. 7 has a white fracture. Carbon is all combined.

The Lake Superior charcoal irons are graded, not by fracture, but by analysis, the following classifications being most generally used:

	Silicon, per cent. Ave'ge.	Min.	Max.	Chill.
A Scotch	2.50	2.38	2.62	
B Scotch	2.25	2.13	2.37	
C Scotch	2.00	1.88	2.12	
Low 1	1.75	1.63	1.87	
High 1	1.50	1.38	1.62	
Low 2	1.25	1.13	1.37	
High 2	1.00	.88	1.12	
Low 3	.75	.63	.87	Trace to ¼ in.
High 3	.56	.50	.62	¼ to ⅝ in.
Low 4	.44	.38	.50	⅝ to 1 in.
High 4	.32	.25	.38	1 to 1½ in.
Low 5	.20	.15	.25	Low Mottled
High 5	.10	.05	.15	White Mottled
No. 6	.00	.00	.05	White
Phosphorus				0.15 to 0.22
Manganese				0.30 to 0.70
Sulphur				Trace to 0.018

Coke.

This is divided into the following classes:

Foundry—This coke is selected from ovens which have burned 72 hours. It is always made on Mondays and Tuesdays, as no work is done at the ovens on Sunday. It may be made on other days of the week by shutting down another day. It is hard and large and has a bright appearance, caused by the carbon condensing or fusing on the surface. This coke is used in cupolas for melting iron and for heavy forging work.

Furnace—This is coke that is burned 48 hours and is used in smelting ores in blast furnaces. It is sometimes used in cupola practice.

Standard Foundry and Furnace Coke—Sulphur under 1 per cent, the lower the better. Ash not over 13 per cent; quality improves with the reduction in ash, until percentage is reduced to a point where structure is weakened.

Smelter coke is either of the above, running, say, over 1.20 per cent in sulphur. While this higher sulphur renders it undesirable for smelting or melting iron, it does no harm in the smelting of most other ores.

Stock—This coke is stocked on the oven yard, instead of being loaded direct into the car. If care is used in selecting this coke when loading, it is as good as if freshly drawn, with the exception that it is somewhat broken up by the double handling and is discolored.

Soft, Heating or Jamb—This coke is the cullings from the above classes and is made up of the backs, fronts, and coke around the oven doors. This is often incorrectly called stock coke.

Crushed Coke—This is crushed and graded according to size into the following classes:

Egg, large stove, small stove, chestnut, ⅞-inch pea, ½-inch pea, dust.

The first four grades are used for house heating, small forgings, etc., the pea coke for chemical works, etc., and the dust for packing the bottoms of soaking pits and crucible furnaces.

Ferro-Alloys.

Owing to the fact that many of the ferro-alloys have only been in use for a comparatively short time, the fixed standards have not in many cases been adopted. One company designates its material by showing the number of units of carbon by "X" and the kind of alloy by its letter symbol, thus a ferro-chrome containing 9.70 carbon, it would designate 9 x C.

All foreign ferro-alloys are sold to the American consumers f. o. b. cars American seaboard, based on present duties, United States custom house weights at seaboard to govern settlement, and upon certificate of foreign chemist of repute to be conclusive as to quality.

Ferro-Aluminum is sold containing 10 per cent aluminum. Higher percentages are also used in iron and steel, No. 1 being guaranteed over 99 per cent pure aluminum. No. 2 is guaranteed over 90 per cent aluminum, with no injurious impurities for alloying with iron and steel. It is sold by the pound.

S. A. M. Alloy. This is an alloy of silicon, aluminum, manganese and iron. One partial analysis showed:

	Per cent.
Silicon	8.01
Aluminum	6.80
Manganese	8.39
Phosphorus	0.075

Ferro-Chrome usually runs 60 per cent to 68 per cent chromium. It is graded per unit of chromium and per unit of carbon, the price increasing with the chromium and decreasing with the increase in carbon, these elements being guaranteed. If low in carbon, it is sometimes called "mild."

A typical analysis only guaranteed as above is as follows:

	Mild, Per cent.	Ordinary, Per cent.
Chromium	64.80	66.00
Iron	33.43	21.91
Carbon	1.21	9.90
Silicon	0.29	1.40
Phosphorus	0.027	0.07
Sulphur	0.02	0.22
Manganese	0.09	0.20
Copper	0.12	....
Aluminum	....	....

It is sold per ton, 2,240 pounds.

Ferro-Manganese contains over 40 per cent manganese.

Standard Ferro-Manganese is only guaranteed to average 80 per cent or over manganese. The English runs lower in phosphorus than that from the continent. A typical analysis, manganese only guaranteed, is as follows:

	English, Per cent.
Manganese	80.50
Iron by dif.	11.50
Silicon	1.65
Phosphorus	0.33
Carbon	6.78
Sulphur	....

It is sold per ton, 2,240 pounds.

Ferro-Molybdenum is sold per pound of pure molybdenum contained, regardless of the percentage of other material. Thus, if a pound of 80 per cent ferro-molybdenum is purchased, 1¼ pounds of the alloy will be received. A typical analysis, the units of molybdenum only guaranteed, is as follows:

	Per cent.
Molybdenum	79.15
Iron	17.55
Carbon	3.24
Phosphorus	0.028
Sulphur	0.021

Nickel. As ordinarily used in steel this is guaranteed over 99 per cent nickel and is sold by the pound.

Ferro-Nickel is also supplied with 25, 35, 50 or 75 per cent of nickel as specified. The balance of analysis outside of the nickel and iron run about:

	Per cent.
Carbon	0.85
Silicon	0.25
Sulphur	0.015
Phosphorus	0.025

Ferro-Phosphorus contains over 10 per cent phosphorus. The foreign is guaranteed 22 to 24 per cent phosphorus.

A typical analysis of foreign, the phosphorus alone being guaranteed, is as follows:

	Per cent.
Phosphorus	21.40
Iron	75.03
Manganese	0.70
Silicon	1.63
Carbon	1.17

The domestic is guaranteed:

	Per cent.
Phosphorus	18 to 22
Sulphur	under 0.05
Manganese	under 0.50

It is sold per ton, 2,240 pounds.

Phosphor-Manganese. A typical analysis is:

	Per cent.
Manganese	65.00
Phosphorus	25.00
Iron	7.00
Carbon	2.00
Silicon	1.00

Silico-Spiegel contains manganese 17 to 22 per cent and silicon 6 to 12 per cent. The standard is guaranteed as follows:

	Per cent.
Manganese	18 to 20
Silicon, 9 to 11 per cent	average 10

A typical analysis, nothing but manganese and silicon guaranteed, is as follows:

	Per cent.
Manganese	20.32
Iron by dif.	68.02
Silicon	10.33
Carbon	1.26
Phosphorus	0.07
Sulphur	....

It is sold per ton, 2,240 pounds.

Special High Silicon contains over 40 per cent silicon. It is guaranteed 50 per cent silicon with an allowance of $1.75 per unit either way. The other elements are not guaranteed. A typical analysis is:

	Per cent.
Silicon	49.90
Manganese	0.16
Carbon	0.55
Phosphorus	0.075
Sulphur	0.018

It is also guaranteed 75 per cent silicon, with an allowance of $2.50 per unit either way. It is sold per ton, 2,240 pounds.

Bessemer Ferro-Silicon. This runs 8 to 16 per cent in silicon, the price usually increasing or decreasing $1 per unit.

The "Domestic" is guaranteed silicon as specified 8 to 16 per cent.

	Per cent.
Phosphorus	not over 0.10
Sulphur	not over 0.05

The "Foreign" is not guaranteed, but phosphorus and sulphur, while not guaranteed, run very low. It is sold per ton 2,240 pounds. For lower percentages of silicon see "High Silicon Irons."

Ferro-Sodium is usually sold with 25 per cent metallic sodium and free from lime or excess of carbon.

Spiegel, Spiegel-Eisen or Mirror Iron contains 10 to 40 per cent of manganese. The standard is guaranteed:

	Per cent.
Manganese, 18 to 22 per cent	average 20
Phosphorus	0.10 or under

The silicon limits are sometimes specified, as it is desirable to know how the same will run. A typical analysis only guaranteed as above, is as follows:

	Per cent.
Manganese	20.50
Iron	73 61
Silicon	0.76
Carbon	5.18
Sulphur	0.002
Phosphorus	0.055

It is sold per ton, 2,240 pounds.

Ferro-Titanium. The lower titanium contents is sold guaranteed only in titanium, which is 10 to 12 per cent, and is sold by the pound of alloy.

A typical analysis:

	Per cent.
Titanium	11.21
Iron by dif.	87.68
Carbon	0.67
Silicon	0.37
Phosphorus	0.04
Sulphur	0.03

If higher in titanium, it is sold per pound of pure titanium contained, regardless of the percentage of other material, the titanium above being specified. A typical analysis is as follows:

	Per cent.
Titanium	51.30
Iron	44.18
Carbon	2.82
Manganese	0.[illegible]
Arsenic	1.1[illegible]
Sulphur	0.04[illegible]
Phosphorus	0.021
Aluminum	0.41

Ferro-Tungsten is sold per pound per unit of tungsten contained, the price increasing with the increase in tungsten and decreasing with the increase in carbon. A typical analysis, the tungsten and carbon only being guaranteed, is as follows:

	Per cent.	Per cent.
Tungsten	85.47	61.20
Iron	13.90	33 02
Carbon	0.30	2.97
Silicon	0.13	0.47
Manganese	0.09	1 88
Aluminum	0.00	0.31
Phosphorus	0.019	0.03
Sulphur	0.025	0.03

Ferro-Vanadium is sold per pound at price per unit of vanadium contained; that is, if alloy contains 20 per cent vanadium and selling price is five cents per unit, it would cost $1 per pound of alloy. A typical analysis as made by one foreign company, vanadium alone being guaranteed, is as follows:

	Per cent.
Vanadium	36.0
Manganese	0.6
Iron	61.0
Carbon	0.4
Silicon	0.9
Aluminum	0.8

MOLDING A CAST STEEL CYLINDER

BY H. J. McCASLIN

MOLDING a cast steel hydraulic cylinder, shown in Fig. 1, on end, not only embodies some novel features in patternmaking, but also in foundry work. This cylinder had an overall length of about 12 feet, an outside diameter of 32 inches and a flange diameter of 56 inches. The metal throughout was 3 inches thick. While cylinders of this design are cast in a vertical position, they are not molded in this way. Some foundrymen prefer to use a complete pattern which is parted longitudinally and the mold is rammed up in a similar way. Following the drying and assembling of the mold, it is up-ended and cast in this position.

Another method is often resorted to when roll flasks are available. These flasks are provided with ends supporting bearings to receive a spindle. Sweeps conforming to the cylindrical portion of the section are attached to the spindle and the two halves of the mold are struck out in this manner. This method will, of course, necessitate the bedding in of the various pattern parts, while the sweeping is in progress. This is, perhaps, the most economical method from the pattern shop viewpoint, provided the rigging is at hand. The barrel portion of the pattern is thus

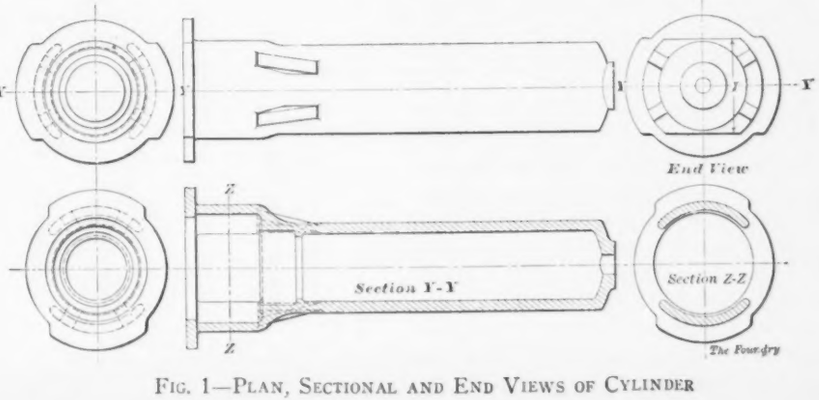
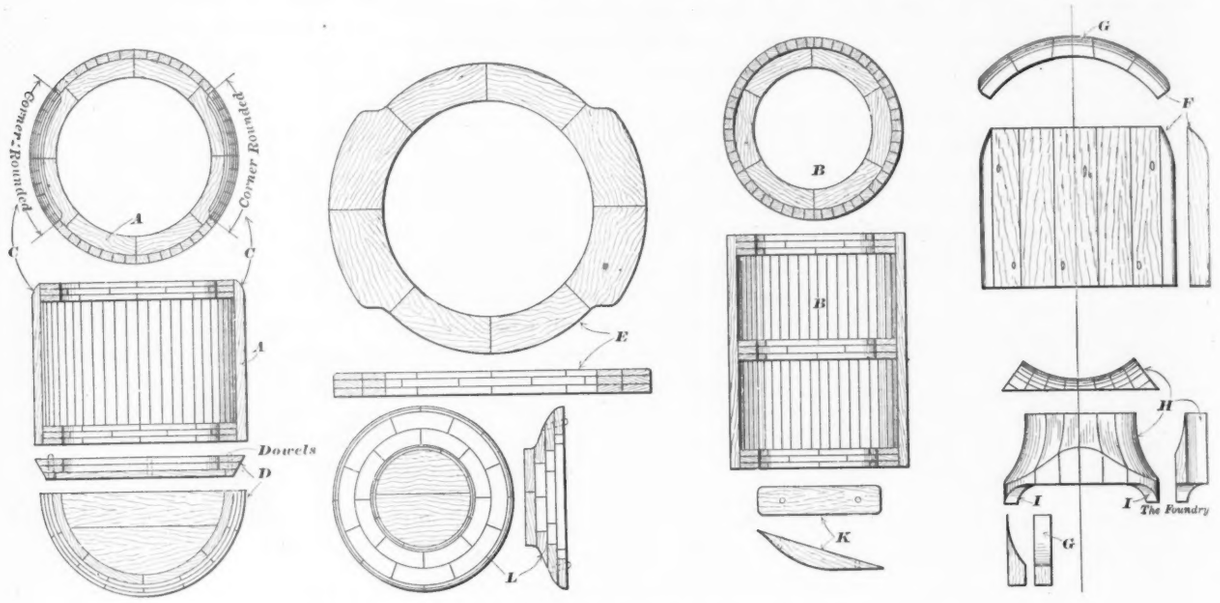


FIG. 1—PLAN, SECTIONAL AND END VIEWS OF CYLINDER

dispensed with and is formed by the sweep previously mentioned. While the method pursued in making this cylinder involved a somewhat greater pattern shop expense than the latter, the final result compared favorably with this method.

taching the parts to the body. As these are inserted from the inside of the barreled-up sections they are easily withdrawn, permitting the parts to remain in position until the mold has reached the finishing stage. In considering the making of the de-

down through the depression left vacant by part A when setting it. It will be found convenient if this part is made a trifle large in diameter, say about 3/16 of an inch. At the point opposite the position it occupies on the bottom end of part A, is the core



FIGS. 2 AND 3—VARIOUS PARTS OF THE CYLINDER PATTERN

The Pattern.

In beginning work upon a pattern of this nature, a full size radial section should be laid out. It is safe to assume when molding a cylinder of this weight, and in this position, that it will contract not less than 3/16 inch per foot. No conventional rule can be laid down for the finish allowance. Castings of this size should, however, have a liberal allowance of not less than 7/16 inch, especially upon the bored out diameters. Before discussing the various pattern parts shown in Figs. 2 and 3, the completed pattern, as shown in Fig. 4, should be studied for the purpose of observing how the parts would appear when placed together. With their respective positions around the body of the pattern well in mind, their form can be more readily observed.

Two cylindrical sections, A and B, make up the body of the pattern. Section A is a core print having an outside diameter equivalent to the inside diameter of the cylinder at this point, section Z-Z, Fig. 1. Section B is a short piece of the desired diameter of the cylinder. This piece is drawn up from time to time until the desired height of the mold has been obtained.

Loose dowels are employed in attailed parts shown in Figs. 2 and 3, we shall begin with part A. It is constructed by lagging over two segment rings. If the rings are sawed out accurately and care is exercised in getting out the lagging, which should be applied in narrow widths, very little dressing will be required to bring it to size. Should it be desired to turn it, it will be found advisable not to round the corner over as shown at C until the parts have been assembled, as the core must pass

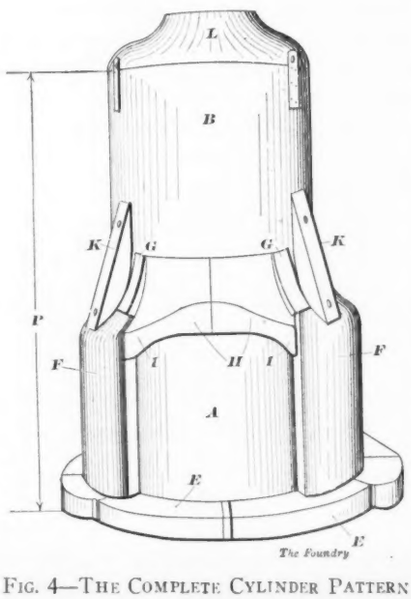


FIG. 4—THE COMPLETE CYLINDER PATTERN

print D used in setting the core. The method of making it can readily be seen and requires no further explanation.

In construction, part B is similar to part A and may have a length of 30 to 36 inches. In making the smaller parts, flange G would receive consideration next. It is made in sections for convenience and its construction is of little consequence. In locating it in its correct position around core print A, only one of its parts must be attached, as the remaining parts can then be assembled in their respective order. Two pieces of part F are required and are set up to A, Fig. 4. While the two ends are doweled for position, the center G is made wedge shape to permit its withdrawal first, allowing the remaining pieces to be left out, that the outer diameter of part F may be filleted in the barrel B. Fillet blocks or pieces G are made as shown in Fig. 3 and set in back of part F as shown in Fig. 4. The pieces G are not fitted nor set together, but are separated by a piece of about 1 inch, the molder filling up these spaces with sand, slicking them off to conform to the blocks before ramming.

Piece H consists of a number of the fillet blocks G, which are fitted and glued together with the position

they are to occupy against parts A and B, provision being made for the fillet I. They are then flattened to the desired width J of the cylinder, as shown in the end view, Fig. 1. Four ribs K are also required, being attached to the pattern in the position shown. The end of the cylinder L shown in Fig. 2 is also required and is of segmental construction turned and doweled to the top of part B.

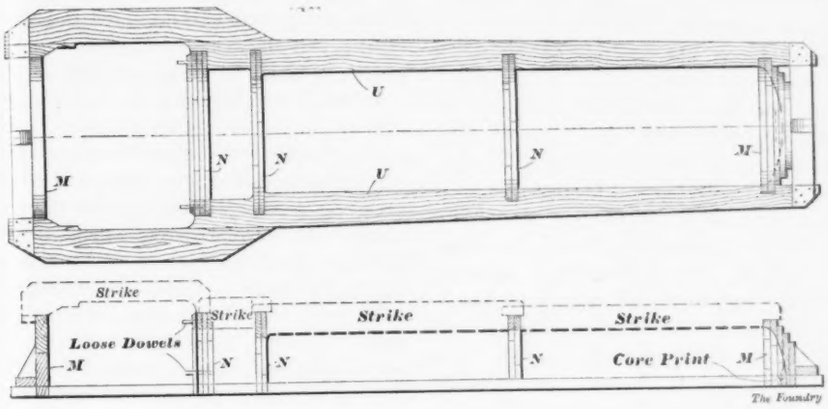


FIG. 5—THE CORE FRAME

The Core and Core Frame.

For the core shown in Fig. 6, which is made in halves, a core frame, Fig. 5, is used. It is constructed of two stringers U, whose inner edges conform to the required outline of the core. To the stringers are attached the two ends M and the semi-circular forms N for guiding the strikes. The strikes are used against the forms N as shown in the dotted lines. As the two half cores are subsequently bolted together, provisions must be made for inserting the bolts and for attaching hooks for handling the core in a vertical position and for bolting it in place to prevent raising when the metal is poured.

Molding.

Shown in Fig. 6 are two radial sections of the completed mold, which illustrate the general arrangement of the partings and the manner of holding down the core. That a good heavy head or riser may be provided, the diameter O is carried up about 2 feet. While the entire mold could be rammed up in the body and lifted up in sections for finishing and drying, in most instances it will be found more convenient to ram it in sections on the floor and then assemble it in the body before casting. When beginning the molding operation, the core print D, shown in Fig. 2, is the first part of the pattern to be used. It is leveled and bedded in the bottom section S of the mold. After a surface has been struck off flush with its upper edge, the core print A is placed upon it and the flange G is set in place. Sand is then rammed to the height of the flange and a parting is prepared at this joint as shown. The pattern is now assembled as shown in Fig. 4 and the ramming of the second section F is undertaken. To insure the ramming up of the mold to the required height, a gage stick is used upon which is marked off the height P of the assembled pattern, and the distances of part B must be drawn before placing on the end piece L, upon which the top section X of the mold is rammed. When the mold has been rammed and the pattern drawn up beyond the parting of the preceding section, the upper section or that containing the pattern, is lifted off and the work resumed. In this manner the work is carried on practically upon the floor and within easy reach of the necessary material. Before ramming the top or cope section X it is advisable to assemble the sections and to try the gage stick to insure that no error has been made in the drawing of the pattern. If found correct part L is placed in position and section X is bolted. To form the diameter O, a large riser block can be used, being drawn up to the desired height. After the various parts have been finished they are placed in the mold drying oven.

Assembling the Mold.

As a casting pit is not always the most convenient place to work, the setting of the core and the partial assembling of the sections may be accomplished on the floor. These sections are then lowered into the pit and the remaining sections are added. When sections S and T have been securely clamped together and blocked up from the floor, so that bolt Q can be reached, the core is lowered into place and sections U V are added. After the core has been tried and set into place to secure an equal distribution of metal, chaplets R are placed into position, and the core is bolted. The assembled sections are then lowered into the pit and the other parts of the mold are added, clamped together and the runner is set in place.

RELATION OF BLAST PRESSURE TO TEMPERATURE.

By W. J. KEEP

Question:—We would like to submit the following questions regarding the relation of the blast pressure to the heat generated in the cupola.

Provided the bed charge of coke is kept constant, and the blast is increased so that the amount of iron melted per hour is likewise increased, will the iron tap out at a higher temperature?

Will increasing the amount of coke

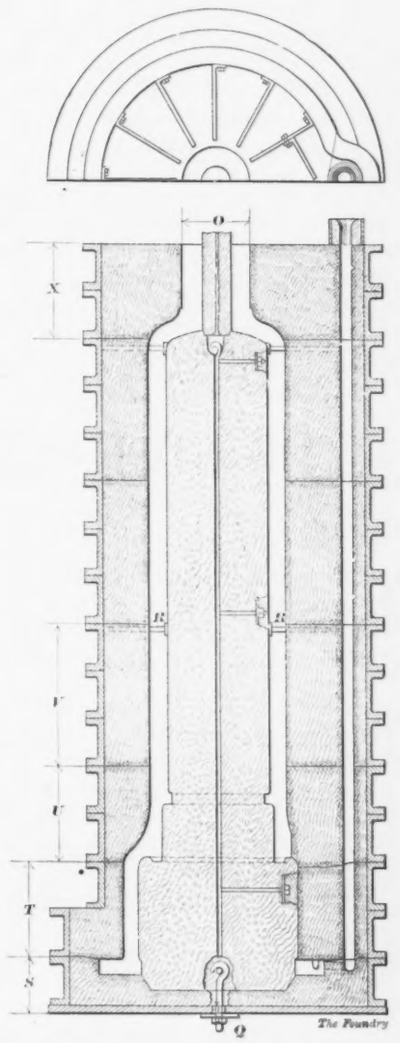


FIG. 6—HALF PLAN AND SECTIONAL VIEW OF THE COMPLETED MOLD

with the blast at a constant pressure increase the temperature of the metal tapped from the cupola, and will decreasing the amount of coke decrease the temperature of the metal?

We have increased our blast from six to 11 ounces, and the result is that we are now melting over a ton of metal per hour more than heretofore. Is not this iron being received from the cupola at a higher pressure than when melting with a pressure of only six ounces?

We have also been informed that increasing the pressure without increasing the amount of coke would not give a hotter iron notwithstanding the fact that we are melting more iron than heretofore.

Answer:—The more rapidly the coke is burned, the faster the heat is developed and the iron is melted in a corresponding ratio. The smaller the charges of coke the faster the melting, but there must necessarily be sufficient coke to make the iron as hot as necessary. The bed simply acts as a scaffold to prevent the iron from passing below the melting point before it is melted. The portion of the bed above the tuyeres is not the bed in the sense just referred to, although it is weighed in as such, because it melts the first charge of iron. With a mild blast this portion will melt the first charge slowly, and with a greater pressure the coke will burn much more rapidly, and will consequently melt the first charge in a shorter time. If exactly the proper amount of coke to melt the iron is used, increasing or lowering the blast pressure to a limited extent will not affect the temperature of the iron. If anything, with increased blast, the iron would not be quite as hot because more free air will be driven through the coke than with a mild blast.

The iron cannot melt until it reaches the melting point. If the coke charge is too large the surplus must be burned out before the iron gets low enough to melt. The burning of this extra coke heats the iron higher up in the cupola and causes it to be hotter when it reaches the melting zone than if the amount of coke actually necessary had been consumed. A slow melting cupola does not necessarily give hot iron, even if slow melting is caused by an excess of coke, because the extra ash clogs the cupola. Six ounces blast pressure is too low, although many foundrymen believe that better results can be obtained with low pressures. For fast melting, 11 ounces pressure is likewise too low, and from 14 to 16 ounces will undoubtedly prove more satisfactory. If the ratio of coke to iron is correct you will have hot iron and fast melting. Poor melting is more frequently the result of too much coke with too low a blast pressure than the result of reverse conditions. The coke charge following the bed charge is intended to melt the charge of iron which is placed upon it, and also to make up for that portion of the bed which was burned out while holding the iron in the hottest part of the cupola until melted. If the coke charge is insufficient to replenish the waste of the bed, the iron will drop too low in the cupola, and when melted will be dull.

THE STORAGE OF PATTERNS

BY JOHN B. SPERRY

NOT long ago it fell to my lot to straighten up and restore to order, the pattern loft of a large manufacturing concern. Through the lack of care and frequent changes of clerks, the loft was in a chaotic condition. Patterns were in one place, core boxes in another, and core prints were scattered everywhere and no records were kept of their location. I will not give complete instructions as to how a pattern loft should be taken care of, but will make a few suggestions regarding the building of shelves and racks for patterns that will make it easier to keep the pattern loft in order, and the patterns in good condition. These racks and shelves were installed in the pattern storage referred to and great economies have been effected.

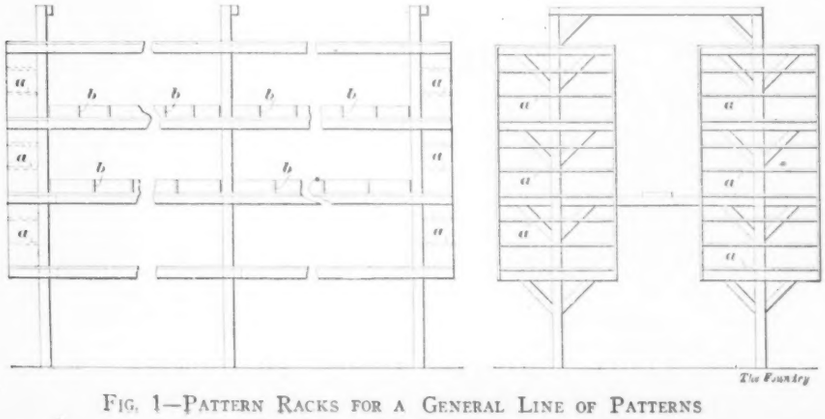


FIG. 1—PATTERN RACKS FOR A GENERAL LINE OF PATTERNS

If the pattern loft contains patterns of several classes of machines, such as pumps, compressors, steam engines, etc., it is advisable to divide the space and have a certain section of the loft for pumps, another for compressors, etc. Do not make too many divisions, as they are confusing, but make a general classification.

In arranging the patterns, the writer found it better to put those that were similar together, and arrange them according to size, beginning with the largest. To illustrate, all pump cylinders were arranged in one section of the loft according to size; piston-heads were placed in another; frames in another and so on through the whole pump division, all like parts being placed in individual sections. It is easier to remember a small number of sections than the individual location of each pattern, hence the advantage offered by this method.

Now a word as to making racks for the patterns. For the general run of patterns, racks with shelves such as is shown in Fig. 1 are very good. They should be built in pairs with staging in between so that the upper shelves can be easily reached. The end of the racks can be divided into small shelves for the smaller patterns, as shown at *a, a*. When core boxes are in several pieces, it is a good plan to build partitions, as shown in Fig. 1 at *b, b*, to prevent parts of one pattern being mixed with parts of another, besides giving the pattern loft an orderly appearance.

Storing Pulley Rims.

The rims of pulley and band wheel patterns are usually separate from the arms to permit the substitution of suitable arms when necessary. To store these rims so that any one can be removed to the foundry without disturbing the rest, take a 2 x 12 inch plank and fasten it to the wall as shown in Fig. 2, and to this plank bolt blocks *b, b*. On these blocks the rims are hung, the smaller ones inside the larger. Several of these racks will probably be necessary.

For storing balance wheel patterns, gear, sprocket, and similar patterns, a good plan is to build what I call an "A" rack, such as is shown in Fig. 3. As will be seen it consists of a number of stalls into which the patterns are rolled, and when one is required in the foundry it can be removed without disturbing the

others. Such a rack is simple to make and is neat in appearance.

It is the custom with some foundries to have patterns that are built on the unit plan, that is a certain number of units or parts go together to form one pattern, and another group form another pattern. Perhaps some of the units included in the first group are also used to form the second. When such a system is used care should be taken to have all units stamped with their number or letter. There should also be a list tacked to the rack where the parts are stored, that shows the different combinations used in forming the different patterns.

In keeping track of patterns, some prefer the card system, while others prefer a pattern record. If the card system or any other pattern record is used, a description of the pattern, with its number and location in the loft should be accurately noted. For the benefit of the foundry foreman the weight of the casting in the rough should be recorded with other information.

FOUNDRYMEN VISIT JAMISON COKE PLANT.

The September meeting of the Pittsburg Foundrymen's Association on Labor Day was the best in point of attendance and enthusiasm in the history of the association. The meeting took the form of a special excursion upon invitation of the Jamison Coal & Coke Co. to the mines and coke operations of the company in Westmoreland county, Pa., and was participated in by 196 foundrymen from Pittsburg and vicinity. Leaving Union station at 8 o'clock Monday morning Sept. 7, the special train composed of five coaches and the largest baggage car on the Pennsylvania railroad, the latter equipped as a special commissary, stopped at East Liberty, Wilmerding, Irwin and Greensburg, taking on delegations from each of those points, and then proceeded to the four coke making plants on the Alexandria branch of the Pennsylvania railroad. Here the visitors were conducted through the mines and washers and around the 1,200 ovens, of which 1,080 were in operation. The foundrymen followed the process of coke making from the mines through the washers, saw the coal taken from the bins, loaded into larries and charged into the ovens, and also watched the operation of drawing the day's production of foundry coke. An elaborate dinner of fried chicken, sweet potatoes and roasting ears was served in a grove adjoining No. 4 plant. Following this, the special train took the party to No. 2 plant where two picked teams finished the day with an exciting and enthusiastic baseball game, after which the foundrymen boarded their train and returned to Pittsburg.

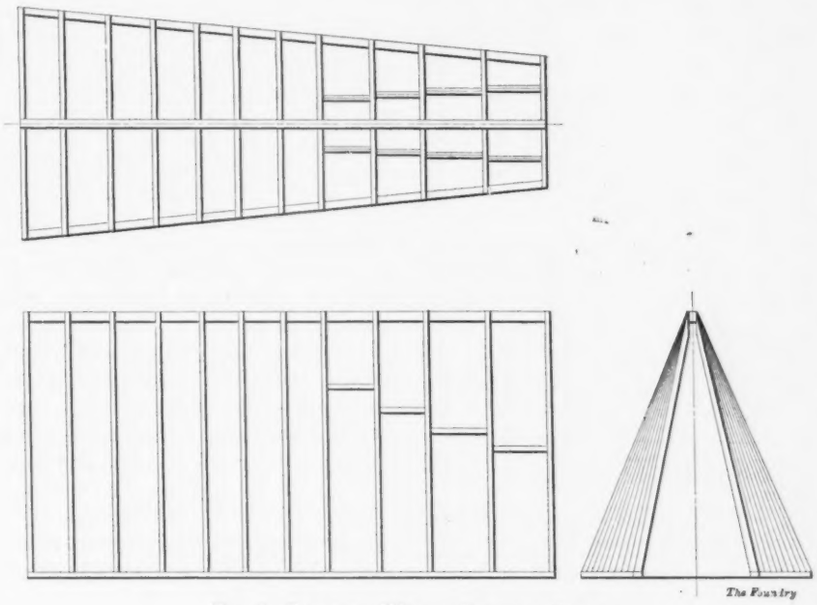


FIG. 3—BALANCE WHEEL PATTERN RACK

At a meeting held after the baseball game, resolutions heartily thanking the Jamison Coal & Coke Co. and W. A. Johnson, sales manager, for the hospitalities extended, were adopted with enthusiasm.

The nominating committee of the foundrymen's association completed its work, and the ticket to be presented at the October meeting for officers through the year 1909, will be as follows: President, C. G. Gale, Pennsylvania Malleable Iron Co.; vice president, J. T. Speer, Pittsburg Valve, Foundry & Construction Co.; treasurer, J. S. Seaman, Seaman-Sleeth & Co.; secretary, F. H. Zimmer, Union Foundry & Machine Co.; executive committee, H. E. Field, Mackintosh-Hemphill & Co.; Benj. Fuller, Westinghouse Electric & Mfg. Co.; E. D. Frohman, S. Obermayer Co.; John A. Logan, W. A. Johnson, Jamison Coal & Coke Co.

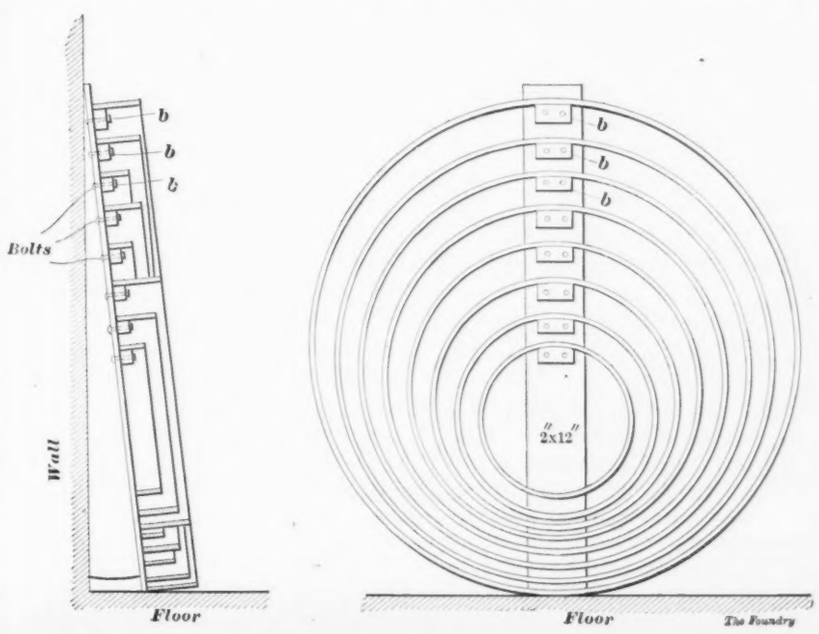


FIG. 2—RACK FOR STORING PULLEY RIM AND BAND WHEEL PATTERNS

Vivian Bond & Co., 68 Beaver street, New York, shippers of pig tin, ferrosilicon, ferro-manganese and other ferro alloys, have established an office in the Frick building annex, Pittsburg, under the management of Andrew C. Daft.

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International Society of Foundrymen

As there promises to be a very large attendance of American foundrymen at the congress of the International Society for Testing Materials, to be held in Copenhagen next year, it has been suggested that the dates of the annual meetings of the British Foundrymen's Association and the German Verein be fixed within a few weeks of each other, to permit of the attendance of the American foundrymen at the three conventions. The organization of an International foundrymen's association could then be dissussed by these foreign bodies, and the American delegates would have an opportunity of conveying the sentiments of American foundrymen in this regard. The subject should be thoroughly discussed at the meeting of the American Foundrymen's Association to be held in Cincinnati next year, and if possible the delegates should attend the gatherings of the foreign founders as representatives of this organization, and should be empowered to act in its behalf. The benefits that can be derived from international communication are many, and the interchange of knowledge will result in greater progress in the world's foundry industry than has been scored in the past. In many respects, foundry practice in Germany and England is unlike that pursued in this country, and while the output per molder may not be as great as in American shops, yet, it is not at all improbable that in finish and wearing qualities, the castings produced abroad may be superior to those made in our most modern plants. Foreign scientists are noted for their research work and many are making a specialty of the metallurgical problems encountered in the foundry. An international organization of this kind would likewise afford American manufacturers of molding machines and equipment an excellent opportunity of presenting the merits of their appliances to foreign users, many of whom have made special visits to this country for the purchase of foundry equipment.

Trade Outlook

The consumption of foundry pig iron is being temporarily affected by the use of an excessive percentage of scrap in the mixtures of many of the large melters, who are drawing upon their scrap piles in preference to making additional purchases of pig iron. The foundry of one large manufacturer is using as high as 83 per cent of old material in its cupola charges, while others are limiting their pig metal to 25 per cent. Very little of this material is being purchased from dealers who are carrying heavy stocks at the present time, but it consists of an accumulation of discarded and scrapped machines and equipment. If this practice is being pursued throughout the country the tonnage of pig iron thus replaced must be tremendous, and the foundry melt is correspondingly greater than the sales of foundry pig iron would indicate. Trade conditions throughout the industry show continued improvement, and many gray iron and malleable plants have increased their number of weekly heats since Sept. 1. Reports of extensions and improvements are also more numerous and manufacturers of equipment report an improved demand. Pig iron producers report the receipt of some inquiries for 1907 requirements, but few sales have been made because sellers generally are disposed to ask prices which the foundrymen are not prepared to meet. Alabama and Virginia operators, being well supplied with orders for early delivery, maintain a firm attitude, while eastern furnaces have stiffened on foundry and forge irons. Furnaces in the Chicago district have met the competition of Mahoning and Shenango Valley makers and have reduced their prices from $17 to $16.50 for No. 2 foundry, at furnace. Ruling quotations on No. 2 foundry grades in the principal centers are as follows: No. 2 standard, Philadelphia, $16.75; No. 2 southern, Cincinnati, $15.75; No. 2 southern, Birmingham, $13; No. 2 northern, Cleveland, $15.25; Bessemer iron is held on a basis of $15.90, Pittsburg, and basic can be had at a reduction of 50 cents from this price. Lake Superior charcoal remains unchanged at $19.50, Chicago.

PERSONAL.

Wm. C. Lang, who, for the past 30 years, has been connected with the National Malleable Castings Co., Cleveland, has resigned.

C. Tolan, of the Philadelphia office of Matthew Addy & Co., pig iron merchants, has been transferred to the Chicago office of that concern.

Henry E. Pridmore, Chicago, manufacturer of molding machines, sailed for Europe several weeks ago. He is expected to return early in November.

Herbert Black, formerly secretary and treasurer of the Robert Field Co., Cincinnati, has become associated with Hickman, Williams & Co., Cincinnati.

W. W. Sly, of the W. W. Sly Mfg. Co., Cleveland, has just returned from a three months' trip to Europe.

David J. Sweet has resigned his position as assistant foreman of the foundry of the King Radiator Co., Toronto. His present address is 781 Park avenue, New York.

H. L. Mills, formerly connected with the sales department of the Whiting Foundry Equipment Co., Harvey, Ill., has resigned to accept the presidency of the American Specialty Co., 1440 Monadnock building, Chicago. This concern is now placing on the market a drill socket of an entirely new type.

Edmund Stanley, who has had a wide experience in the foundry trade is now associated with the Ontario Wind Engine & Pump Co., Ltd., Toronto, Ont., and has charge of the sale of the gravity molding machine sold by this concern in Canada.

W. M. Corse, assistant superintendent of the Detroit Lubricator Co., Detroit, has accepted the position of assistant manager of the Michigan Smelting & Refining Co., Ltd., of the same place, and will assume his new duties on Nov. 1. He will have full charge of this plant, which makes a specialty of ingot brass to specifications, and also produces solder and white metals. A completely equipped chemical laboratory for alloy work will be installed. Mr. Corse is secretary of the American Brass Founders' Association.

H. Truesdell has severed his connections with the Cyclone Brake Bar Co., Buffalo, and is now associated with the Fillmore Avenue Foundry & Iron Works, Inc., of the same place.

OBITUARY.

Geo. G. Blackwell, founder and senior member of Geo. G. Blackwell Sons & Co., Ltd., Liverpool, England, died Aug. 26. Mr. Blackwell was well known in this country, having made frequent visits here for the purpose of extending the sale of the special alloys manufactured by this firm.

SPONGY BRASS CASTINGS.

Question:—The brass castings we are making are badly honeycombed, and we would like to have a mixture that will overcome our difficulties. We are using copper, 100 pounds; block tin, 10 pounds; ordinary scrap, 200 pounds, and two ounces of phosphor tin. Can you give us us a mixture that will prove satisfactory for our use, containing two-thirds scrap?

Answer:—There is nothing wrong with the mixture you are using, although you should not use less, nor more than 2 per cent of phosphor tin. Your mixture will make good castings, provided the scrap is not of the same composition as your mixture. If you buy this scrap in the open market it will contain all of the zinc necessary to make your addition of new alloy cast sound. Otherwise increase your phosphor tin to the quantity stated above. The scrap does not injure your new mixture, as many concerns use all scrap and get excellent results. You must rely on the two-thirds scrap to make your mixture run solid, inasmuch as without the same it is difficult to obtain solid castings from your alloy, as it contains no deoxidizing element, or perhaps an insufficient amount to insure good results. The solidity of the metal will depend on the manner in which it was melted. However, with two-thirds scrap the fault is not in your metal. It lies in your method of melting.

Melting Methods.

You are undoubtedly burning your metal and your melter will probably be indignant when you tell him this. We would suggest that you melt a few heats, observing the following rules:

Charge the copper first, if you use ingot copper, and if you use scrap copper wire, charge the brass first, and at the same time add charcoal, or pieces of hard wood which will make charcoal. In the case of ingot copper, when it becomes heated and begins to melt, charge the brass as well as the charcoal, but do not wait until the portion of the charge in the bed is melted before charging cold metal. As it sinks down into the crucible feed in the cold material until the entire charge is underneath a cover of charcoal. Then you can add your mixture and superheat your metal to the proper casting temperature. In the case of scrap copper wire, it is best to first run down the brass scrap under charcoal, charge the wire, allow it to become just red, then push under the surface of the melted brass, and repeat this operation until the copper is entirely in the bath. After this add the mixture and superheat as before. When the metal begins to melt it will require constant attention, and if cared for as outlined above, you will never have spongy castings.

The writer had an experience which can be cited to advantage at this time. We made heavy bearing bushings for two years that were machined all over, and we never had a porous casting. The melter was granted a vacation and a new man was placed in charge. Trouble resulted immediately and the castings were practically metal sponges. The cause of the trouble—the melter—was taken to task, but he indignantly denied that he was at fault, asserting that it must be the metal, the molder, anything and everybody but himself. To prove to him his responsibility, the foreman did the melting on the next order for this particular lot of castings, using the same metal that the former melter has used, and the castings were as solid as ever. Our friend, however, was still unconvinced, so we decided to give him another chance. He was allowed to make one day's run of bushings, and the results were awaited with interest. The castings were not quite as bad as those resulting from his first attempt, but the result showed a loss of practically 50 per cent. After our melter returned from his vacation our trouble ceased. My advice to all who have this trouble is "watch your furnaces."

K. K.

ANNEALING STEEL CASTINGS.

The regular monthly meeting of the Associated Foundry Foremen of Philadelphia and vicinity was held on Tuesday evening, Sept. 15, at the rooms of the Twentieth Century Quakers, 1034 Arch street, Philadelphia. The principal feature of the meeting was an address on the annealing of steel castings by C. B. Baumgartner, of the testing department of the American Bridge Co. The purpose of annealing, importance of uniform heating and slow cooling, types of furnaces, burners, arrangement of various sizes of castings in the furnace and their position with relation to the direction of the flame, were discussed and high temperature measuring instruments described.

The talk aroused considerable interest and led to a general discussion of oil burners, air compressors, fuel consumption, fuel oil, etc.

USE OF ALUMINUM SCRAP.

Much difficulty is frequently experienced melting aluminum borings, broken scrap, etc. The exposure of the metal results in undue oxidation and oxide usually results, leaving very little of the metal.

When melting scrap aluminum it is advisable to melt the heavier pieces first in a large crucible and when the metal has reached a red heat the smaller pieces of scrap and borings can be added. The borings should be pushed down into the molten bath as rapidly as possible and the metal should be well stirred.

FOUNDRY & PATTERN SHOP EQUIPMENT

Sand blast equipment---A molding machine chuck--- Aluminum melting furnace --Revolving foundry crane

ONE of the important problems for which American foundry practice has as yet found a very imperfect solution is the cleaning in large quantities of very light castings, the production of which is frequently a specialty in some of the more extensive plants. In this regard considerably more progress has been made by European foundrymen, who have devised various methods, of more or less value, for the rapid handling of small castings in bulk, but their success has rarely been so marked as to warrant the adoption of their methods and devices on this side of the Atlantic. It cannot be denied, however, that important economies are certain to ensue from the development of a satisfactory system, not only through the rapidity, ease and thoroughness of the work accomplished, but also through repeated use of the sand and the elimination of the dust-laden sand blast room.

In Fig. 1 is shown an automatic cleaning device designed for use in connection with the injector sand blast apparatus made by C. Drucklieb, 132 Reade street, New York City. In its essentials, this device consists of a steel plate conveyor arranged to carry the castings beneath the sweeping blast from a series of suspended nozzles, to which a rocking motion is imparted, with suitable arrangements for disposing of the castings and the sand. The device is simple; it can be operated by any power available in the foundry, there are no complicated parts to get out of order and but little floor room is required. In fact, as the entire apparatus is encased and an exhaust fan is provided at the rear, it can be operated without discomfort in the foundry proper, thus doing away with the room usually set apart for this work.

Rocking the Blast.

This device incorporates as its primary feature the rocking of the blast, a principle adopted in a tumbling barrel designed by Mr. Drucklieb. The superiority pointed out for this arrangement over that of the stationary blast is that by the rocking motion secured every casting in the barrel is given uniform treatment; there are no zones between those sections immediately beneath the nozzles in which comparatively little work is done, for with the slowly sweeping blast each casting at one time or another is certain to come directly beneath one of the nozzles and to remain there sufficiently long for the cleaning process.

In the arrangement under description a number of nozzles—dependent upon the width of the machine and the rapidity of treatment desired—are fitted to an iron pipe, which is suspended above the conveyor at right angles to the direction in which it travels. These nozzles at their tips are about 6 inches from the surface of the plate; they are inclined slightly toward the rear, as the resulting deflection of the blast by the plate facilitates the cleaning of the under side of the casting as well as the top. This

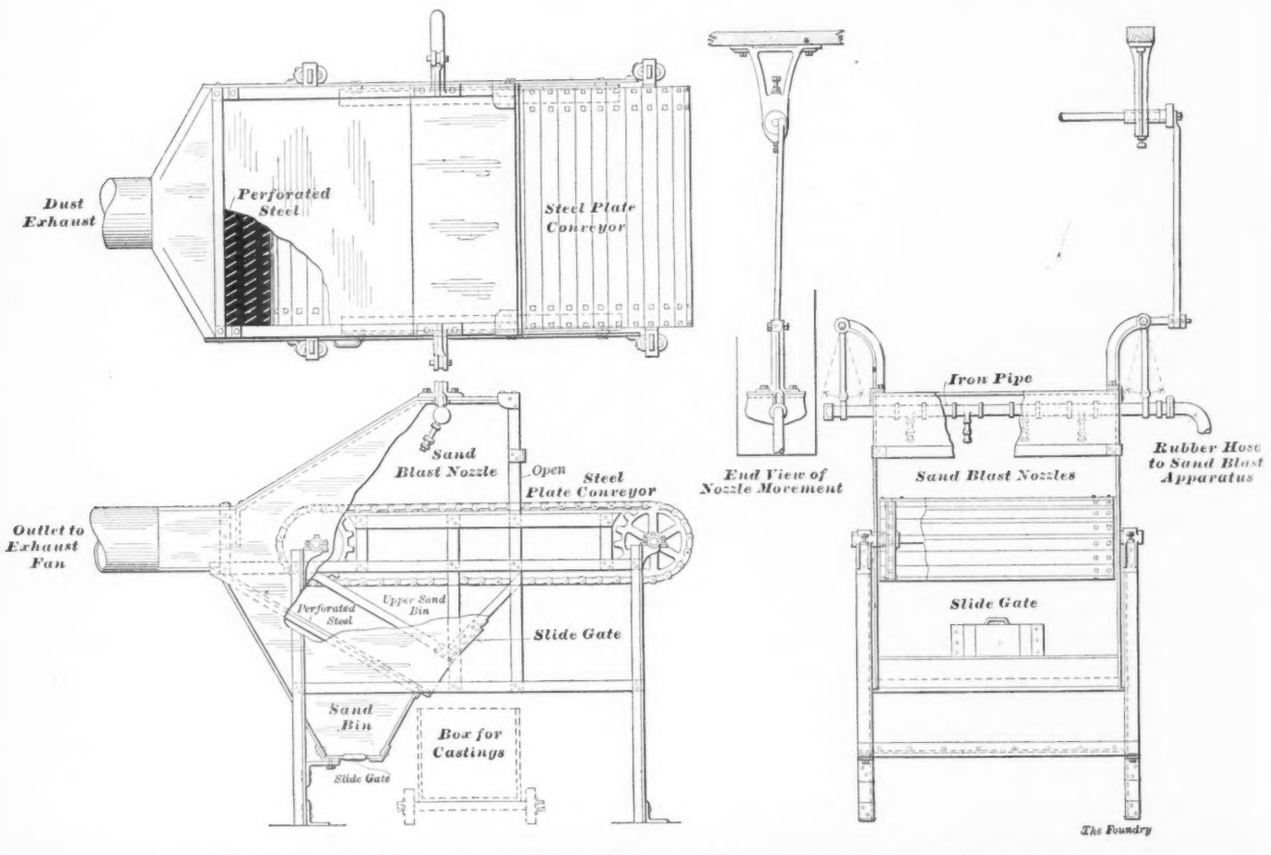


FIG. 1—PLAN, SECTIONAL AND FRONT VIEWS OF AUTOMATIC SAND BLAST DEVICE

iron pipe is closed at one end and connects at the other with a rubber hose running to the sand blast apparatus. On the closed end the pipe is merely hinged to a support built up from the body of the device, but at the other there is provided a bell crank, to which a reciprocating motion is imparted by a disc crank on a hanger above, or by a motor located on the top of the housing.

Conveyor.

The castings are shoveled onto the conveyor at the front and travel through the machine at any desired speed, 8 or 10 feet a minute being the usual rate, as this affords ample time for the sweeping motion of the blast to cover every section of the plate. After passing under the blast, the castings fall onto an inclined steel plate, through the perforations in which the sand falls into a lower bin from which it can be taken for later use. An upper sand bin is located just beneath the path of the conveyor plate on its return trip and catches whatever sand does not fall to the lower bin. The castings chute leads either to a suitable box beneath the machine or to a table for inspection.

Uniform Results.

For the most part it will be found that one trip under the sand blast is sufficient to clean the casting on both sides. Where extremely uniform results are required, however, it is necessary to return some few of the castings to the conveyor for further treatment of the under side. It is the usual practice abroad, where automatic cleaning devices are employed, to return practically all castings for a second treatment, one common arrangement being to place them on a table revolving beneath a blast and station a workman at one side to turn all passing before him that require it and to put on and remove the castings as needed to maintain continuous operation.

The Drucklieb device is designed throughout to use materials of standard specifications. Every part can thus be easily replaced, a feature of importance in view of the excessive wear on any material coming in contact with the sand blast. The chamber in which the cleaning is done is almost entirely encased, the opening in the front being high enough only to admit the load of castings on the conveyor. The direction of the blast is toward the rear and this, with the draft of the exhaust fan, carries off the dust and dirt commonly encountered in sand blast practice, rendering the operator free from danger and discomfort.

Cleaning Large Castings.

Where a considerable number of large castings of similar type are to be cleaned, an arrangement of sand blast equipment also designed and built by C. Drucklieb offers some remarkable advantages in ease and speed of handling and in economy of floor space, all factors of importance in the brisk competition of present day foundry operations. In the installation shown in Figs. 2 and 3, which has been in use for some time with signal success in several forms, heavy car coupler castings are treated.

In the corner of the foundry, not far from the heating furnace, is located a battery of three, hooded sand blasts, so arranged that a single trolley line, with proper switching facilities, serves them all without confusion or delay. As they come from the furnace, the castings are transferred to the cooling floor, where they remain until they lose their color and are sufficiently cool for sand blast work. One of the castings is then picked up by tongs attached to a trolley and swung around to one of the blasts, entering through an opening in the side and a slit in the roof of the case. The front is open, and through this the operator applies the blast, operating a nozzle by hand. The casting hangs on a swivel

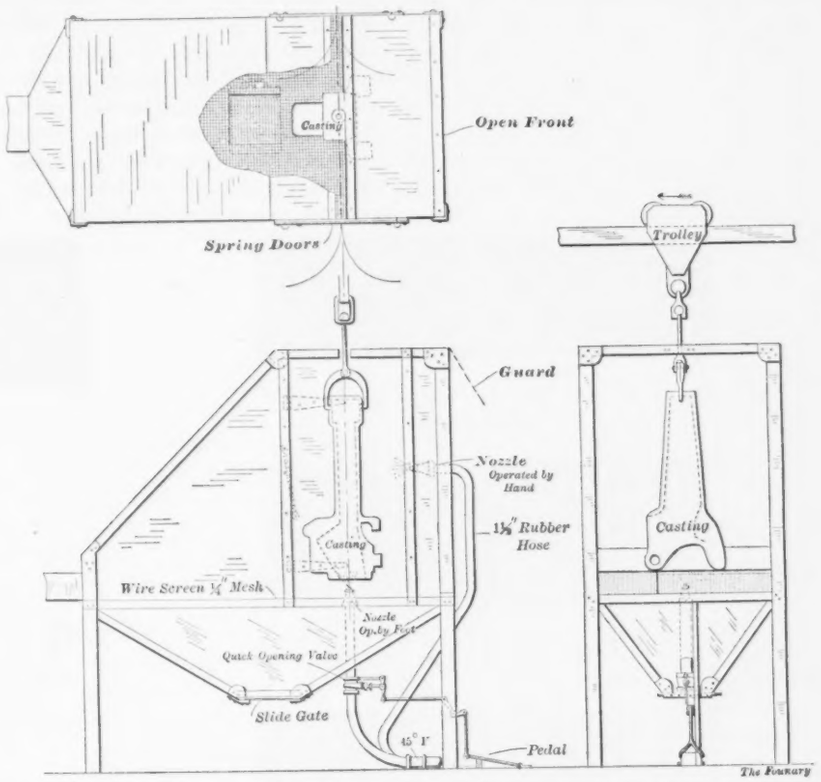


FIG. 2—PLAN, SIDE AND FRONT ELEVATION OF DEVICE FOR SAND BLASTING COUPLER CASTINGS

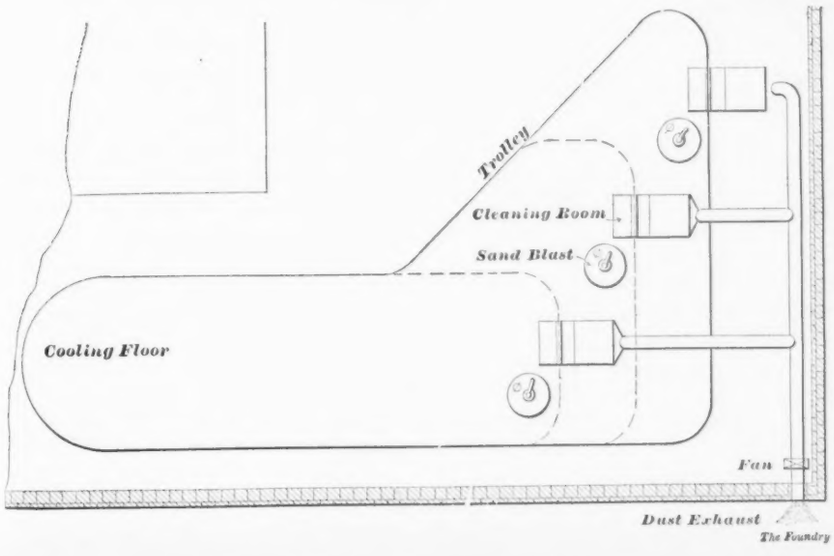


FIG. 3—FLOOR PLAN SHOWING THE ARRANGEMENT OF THREE SAND BLAST MACHINES

and, when the front is treated, this is swung partly around with a hook and the other sides are cleaned. After the outside treatment is complete, the hollow center is cleaned by a blast from beneath, the valve of which is controlled by a pedal.

Just below the lower level of the casting a wire screen of ¼-inch mesh is provided to catch the heavier particles blown off, the sand dropping through into a bin equipped with a slide gate. The front of the device is open, except for a small guard for the operator's eyes at the top, but the three hoods connect at the back with an exhaust fan system and all dust is taken care of in this manner. The process is continuous, the castings swinging through the cleaners and returning to the storage and inspection floor in a complete circuit, without any change of direction.

FIG. 1—CLICHE FOR MOLDING TWO CASTINGS IN ONE OPERATION

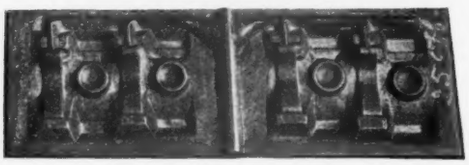


FIG. 2—CLICHE FOR MOLDING EIGHT CASTINGS IN ONE OPERATION

FIG. 3—CLICHE FOR MOLDING SIX CASTINGS IN ONE OPERATION

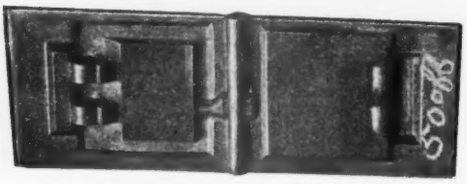


FIG. 4—CLICHE FOR MOLDING TWO CASTINGS IN ONE OPERATION

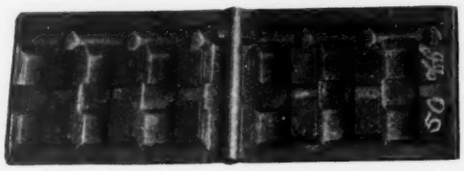


FIG. 5—CLICHE FOR MOLDING TWELVE CASTINGS IN ONE OPERATION

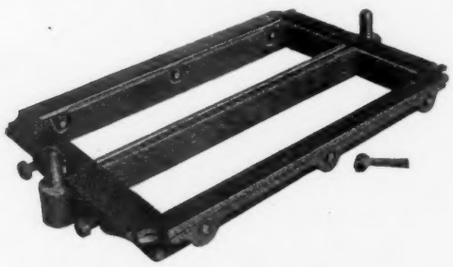


FIG. 6—THE PATTERN CHUCK

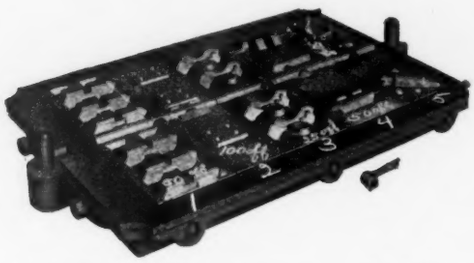


FIG. 7—CHUCK WITH CLICHES FOR FIVE DIFFERENT PATTERNS READY FOR MOLDING

A MOLDING MACHINE CHUCK.

Cliche or sectional, reversible match plates and the chuck in which they are held for use on molding machines, are shown in the accompanying illustrations. This cliche process was introduced by P. H. Bonvillain and E. Ronceray, Paris, France, and the exclusive American rights are now controlled by the E. H. Mumford Co., Philadelphia. If it is desired to make 100 castings of a certain kind with this apparatus, a cliche is made for molding two castings at a time as shown in Fig. 1, from which 50 molds will be made. If 200 castings, as shown in Fig. 2, are to be made, a cliche is produced for molding eight at a time and 25 molds will be run from it. If 600 castings, as shown in Fig. 3, are to be made, a cliche is produced as illustrated for making six in one operation and 100 molds are made from this cliche. Fig. 4 shows a cliche from which 100 castings are to be made and, therefore, 50 molds are to be produced, and in the same way another cliche, shown in Fig. 5, for molding 12 castings at a time is made, and if 600 of these are desired 50 molds are made. These five cliches are locked in the pattern chuck shown in Fig. 6, in which the different cliches are all matched by tongues on their backs fitting the grooves shown in the center bar of the chuck and are held in place by the screw-driven follower shown at one end, and are clamped on their bed by the battens at the right and left sides by the use of the small wrench shown near the chuck. The chuck with the cliches for five different castings ready for molding is shown in Fig. 7. While the cliche shown in Fig. 3 is producing its 600 castings the other cliches will run out their orders and are replaced by other cliches to occupy this space. This operation requires a fraction of a minute to accomplish. This apparatus may be used on any power molding machine, on a hand squeezer or on a bench. On reversed match plate work of larger size, such as stove and range parts, larger cliche apparatus with perhaps only two castings in a mold would be employed.

TRADE NOTES.

The Societe Anonyme Electrometallurgique, Procedes Paul Girod, Ugine (Savoie) France, has appointed G. W. Leavitt & Co., New York City, selling agents for the Girod process of electrical manufacture of steel. The Girod electric steel furnaces have all of the benefits of the refining action of the arc furnaces, but it is claimed they offer additional advantages in the way

of regularity of operations as the induction furnaces.

The National Battery Co., Buffalo, announces that the receivership under which this concern has been operating since last February has been terminated. Full control of the reorganization of the company has been secured by the Cutler Hammer Mfg. Co., Milwaukee, manufacturers of battery charging rheostats and other electric controlling devices. The plant of the National Battery Co. will remain at Buffalo, but the business will be conducted under a new management with ample capital.

The torch was applied to the new furnace of the Hamilton Iron & Steel Co., Hamilton, O., on Saturday, Aug. 22. The product of this stack is to be known as Miami, a typical northern foundry iron, which will be marketed

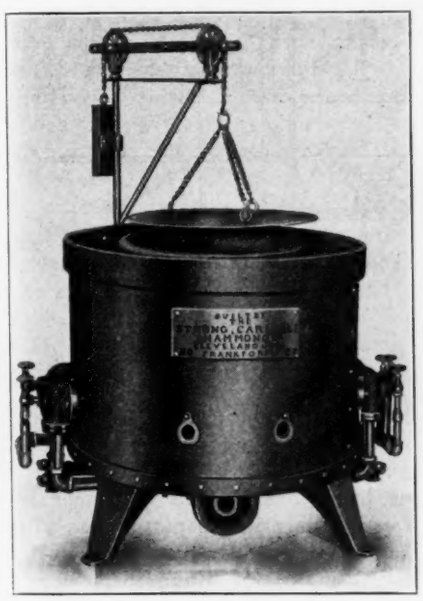


FIG. 1—ALUMINUM MELTING FURNACE

exclusively by Walter-Wallingford & Co., Cincinnati and Pittsburg.

The Cleveland Crane & Car Co., Wickliffe, O., has established an office at 1203 Marquette building, Chicago. W. A. Rider is resident manager.

The Lackawanna Steel Co. has decided to operate as merchant furnaces, its several stacks located in the Lebanon Valley, Pennsylvania, for the production of foundry, forge, Bessemer and low phosphorus pig iron, and has associated with it Crocker Bros., 99 John street, New York, as exclusive sales agents for the distribution of its product in the various markets both east and west.

The Schaeffer & Budenberg Co. has sold its plant at Foxboro, Mass., to the Industrial Instrument Co., recently organized with Bennett B. Bristol, formerly of the Bristol Co., Waterbury, Mass., manufacturer of recording instruments, at its head. The Standard Gage Mfg. Co. will operate the plant for the manufacture of gages, recording instruments, etc., and the property will be deeded to this company by the Industrial Instrument Co., as the same interests control both concerns. Watson E. Goodyear, Naugatuck, Conn., will be president of the Standard Gage Mfg. Co., Bennett B. Bristol, treasurer, and Arthur F. Mundy, Syracuse, N. Y., secretary. The plant is well equipped and consists of two brick buildings 60 x 210 feet each. and a foundry 60 x 150 feet.

The Fillmore Avenue Foundry & Iron Works, Inc., Buffalo, N. Y., has secured the contract for the construction of the melting furnaces and annealing ovens for the new plant of the Torrence Malleable Iron Co., at Voorheesville, N. Y. This plant is to be equipped entirely with the Truesdell system of melting and annealing cast iron for malleable purposes. H. Truesdell, formerly with the Cyclone Grate Bar Co., Buffalo, and now associated with the Fillmore Avenue Foundry & Iron Works, Inc., will have charge of this installation.

Members of the Central Association of Stove Manufacturers witnessed a demonstration of the molding of oven doors and fire pots at Columbus, on Sept. 15. The machines were of the rockover type built by Henry E. Pridmore, molding machine manufacturer, Chicago.

The Chicago Milling Co., Chicago and Riverdale, Ill., manufacturer of the "Black Diamond" core compound, announces that it is in no wise affected by the failure of its sellings agents, the Millers' Products Co., Thirty-ninth and Wallace streets, Chicago. The "Black Diamond" core compound hereafter will be advertised and distributed under the manufacturers' own name. The company reports gratifying success with its new product, orders for the same having been received from every state in the union, Canada and other foreign countries, many of them repeat orders.

THE FRANKFORT MELTING FURNACE.

The furnace shown in Figs. 1 and 2, built by the Strong, Carlisle & Hammond Co., Cleveland, is designed for melting the softer metals, particularly aluminum. It is equipped with four Weintz natural gas burners, having a fuel consumption of 200 cubic feet per hour, and either artificial gas or oil burners are furnished as required. The air tank is suspended underneath the furnace which is well supported on four cast iron legs. Melting pots either 20 x 24 x 12 inches or 20 x 24 x 18 inches can be used and a hood to carry off the fumes, as well as a blower, are furnished when specified. The cover is suspended by a counterweighted chain and can be easily raised and lowered. The furnace has a melting capacity of 460 pounds of aluminum, and it is claimed that the melting temperature is quickly attained and can be maintained with precision, throughout the melting period. Five hundred pounds of aluminum can be melted in 75 minutes. The floor space required is 42 x 53 inches and the height of the furnace from the floor to the top of the pot is 32 inches. In addition to melting the softer metals, the furnace can be used for hardening in lead or cyanide.

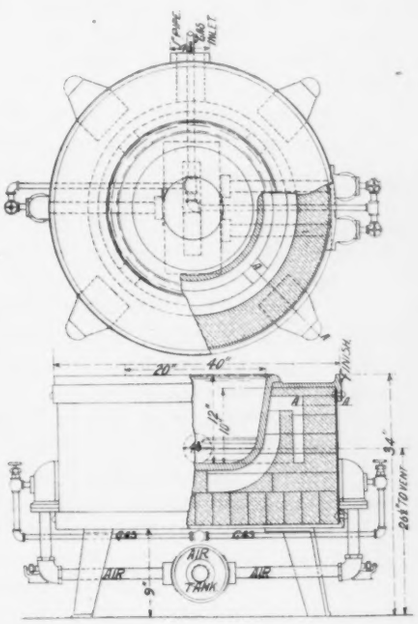


FIG. 2—PLAN, FRONT AND SECTIONAL VIEWS OF ALUMINUM MELTING FURNACE

PHILADELPHIA FOUNDRYMEN'S ASSOCIATION.

The Philadelphia Foundrymen's Association held its first meeting after the summer recess in the new Manufacturers' Club, Broad and Chestnut streets, Philadelphia, formerly the old Hotel Bellevue, Wednesday evening, Sept. 2.

The attendance was large. Thomas Devlin, of the Thos. Devlin Mfg. Co., president of the association, was in the chair. In a speech of greeting on the opening of the season of 1908-1909, he felicitated the members on the elegant new quarters available to the association and urged all who

were not already members to join the Manufacturers' Club.

H. C. Moyer & Co., iron and steel merchants, Pennsylvania building, Philadelphia, was elected a member of the association.

Two papers were read by Thomas D. West, of the Thomas D. West Foundry Co. and president of the American Anti-Accident Association, Sharpsville, Pa. The first was on "Foundry Accidents vs. Safety Devices and Needed Data," and the latter on "Burning Long Sections of Broken Iron Castings."

In connection with his first paper Mr. West exhibited a blank data sheet which he proposes sending to foundrymen and other employers for the purpose of collecting information as to accidents with a view to its use in influencing legislation. He spoke of the work of the American Anti-Accident Association and urged those present to use their influence for a sane and safe Fourth of July. Mr. West referred to the shameful waste of natural resources of the country and of the poor workmanship which is so common. He said that there is altogether too much toleration for the unskilled worker. In order to remedy existing conditions, Mr. West proposes, first, the opening of every possible avenue to afford boys and girls opportunities for employment to be governed by such rules as will require continuance in that employment until full apprenticeships have been served; secondly, that the general public be so educated that citizens in general will consider the mastery of a vocation paramount to the question of wages paid while the vocation is being learned, and thirdly, that earnest, systematic effort be made to utilize the labor of American workingmen to the best advantage.

In his second paper, Mr. West gave a detailed description of the reuniting of a broken propeller wheel blade, as done by the Mobile Pulley & Machine Works, Mobile, Ala.

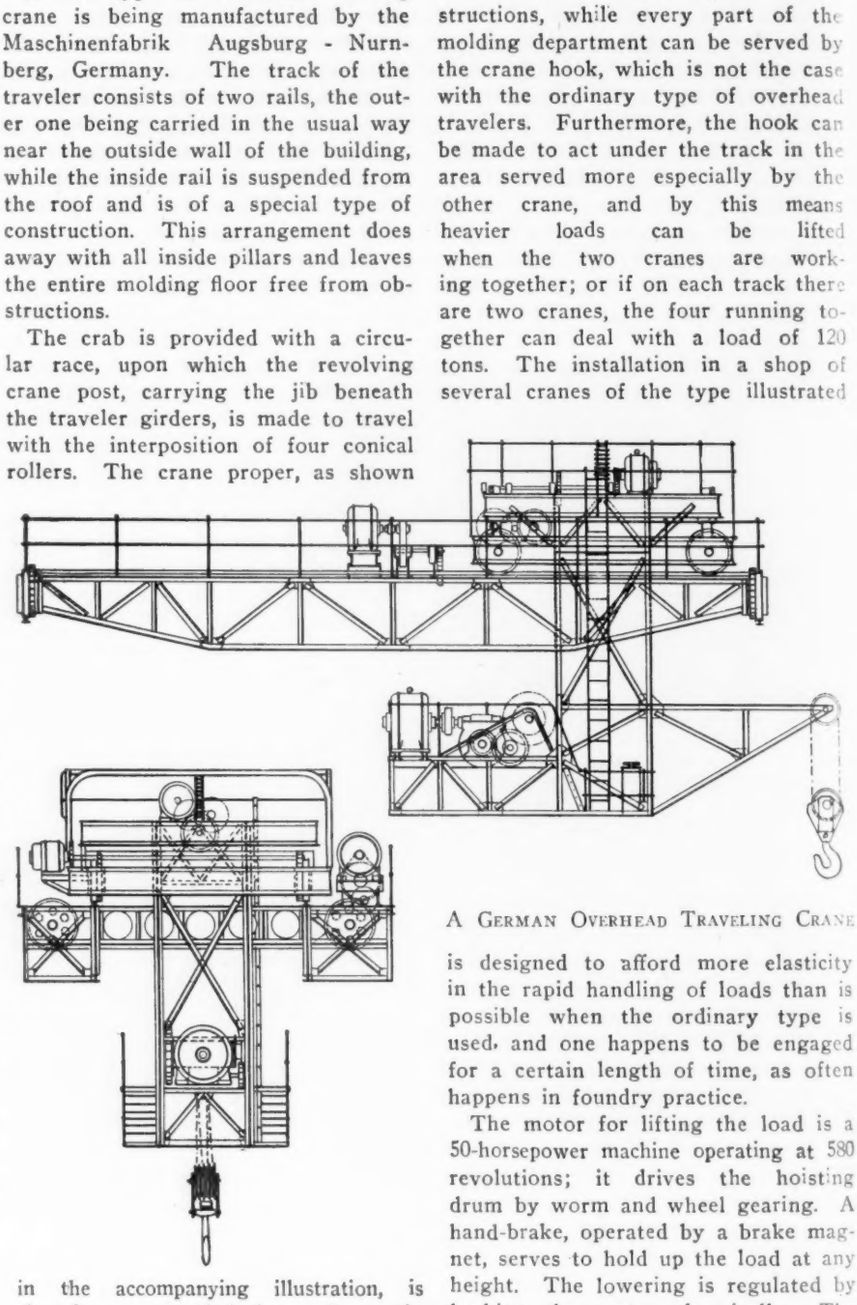
Both papers were followed by interesting discussions.

A luncheon was served in the club dining room after the business session. Dr. E. E. Brown acted as toastmaster. Several impromptu toasts were made, all expressing optimistic views as to future business conditions. President Thomas Devlin made a plea for higher freight rates, arguing that such was necessary to lift the railroads from their difficulties and reestablish them as buyers.

OVERHEAD TRAVELING FOUNDRY CRANE.

A new type of overhead traveling crane is being manufactured by the Maschinenfabrik Augsburg - Nurnberg, Germany. The track of the traveler consists of two rails, the outer one being carried in the usual way near the outside wall of the building, while the inside rail is suspended from the roof and is of a special type of construction. This arrangement does away with all inside pillars and leaves the entire molding floor free from obstructions.

The crab is provided with a circular race, upon which the revolving crane post, carrying the jib beneath the traveler girders, is made to travel with the interposition of four conical rollers. The crane proper, as shown



A German Overhead Traveling Crane

in the accompanying illustration, is therefore suspended from the crab, and is free to revolve underneath the traveler. The rear end of the crane carries the counterweight and the lifting drums. The driver's cab is at the base of the jib, and is fitted with the four controllers which govern the four separate electric motors for hoisting and slewing the load, traversing the crab, and traveling. The current, three-phase at 500 volts, is supplied by sliding contacts from a conduit which lies parallel with the traveler track. The main features of the traveler are as follows: Normal lifting power, 30 tons; span of traveler, 43 feet; center of crane-post to center of hook, 13 feet; lift, 30 feet.

The special advantage claimed for this type of crane is that it leaves the entire floor area absolutely free of obstructions, while every part of the molding department can be served by the crane hook, which is not the case with the ordinary type of overhead travelers. Furthermore, the hook can be made to act under the track in the area served more especially by the other crane, and by this means heavier loads can be lifted when the two cranes are working together; or if on each track there are two cranes, the four running together can deal with a load of 120 tons. The installation in a shop of several cranes of the type illustrated is designed to afford more elasticity in the rapid handling of loads than is possible when the ordinary type is used, and one happens to be engaged for a certain length of time, as often happens in foundry practice.

The motor for lifting the load is a 50-horsepower machine operating at 580 revolutions; it drives the hoisting drum by worm and wheel gearing. A hand-brake, operated by a brake magnet, serves to hold up the load at any height. The lowering is regulated by braking the motor electrically. The jib-crane is revolved by a 12-horsepower motor running at 950 revolutions, which operates by gearing two of the rollers above referred to. A similar motor supplies the necessary power for traversing the crab, and operates the four wheels. Longitudinal travel of the overhead crane is obtained by a 40-horsepower, 580-revolution machine, which drives by gearing two of the four traveling wheels. The following are the speeds per minute with a 30-ton load: traveling, 164 feet; lifting, 13 feet to 16 feet; traversing, 49 feet; while the jib-crane can be slewed round completely in 45 seconds.

MIXING AND MELTING MANGANESE BRONZE.

Question:—We are making manganese bronze consisting of copper, 55; zinc, 43; iron, 1 and aluminum, 1. In the entire mixture only one or two pounds of manganese are used, which might be left out entirely, as the effects from this small amount are hardly perceptible. All of these metals are mixed direct, although I am of the opinion that the proper way of mixing these is to melt the manganese and copper and the zinc and iron together, and to subsequently mix these two mixtures. Will you kindly advise us how to properly charge these metals to secure a satisfactory mixture?

Answer:—You do not state in what form you are using manganese, but we presume it is the grade generally used containing 80 per cent of manganese. In trying out your formula I used 2 per cent of ferro-manganese, which was melted with a portion of the copper, about 10 pounds, and iron, which was in the form of a very thin plate. The high melting points of manganese and iron make it necessary to heat the copper to a very high temperature to dissolve these metals in the mixture. Overheating the copper in this way is very undesirable, but is unavoidable when the alloy is made from what might almost be termed raw materials. For this reason, as little as possible of the copper should be exposed to this high temperature. When the manganese and iron are dissolved (which can be ascertained by probing with a slender iron bar) the balance of the copper should be added. The metal should be kept under a cover of charcoal throughout the melting operation, and after the copper has been melted the aluminum should be added, and the zinc should be dropped into the pot after the aluminum. The metal should be well stirred and run into ingots. It is not necessary to run manganese bronze into ingots in all cases, except when the content of zinc is as high as in the formula given above. Casting in ingots may result in the saving of many castings inasmuch as these metals should be mixed very carefully as the alloy is liable to be very brittle. I tested the formula in two ways, first with the iron and then without it, and the alloy containing the iron was the better of the two from the appearance of the fractures. Both alloys ran clean castings in sand, but the fractures of these sand castings were not homogeneous, and were marred by yellow patches. I believe the formula is too high in zinc and aluminum, and it would be more dependable for running into castings direct if the zinc were reduced to 36 pounds and the aluminum to eight ounces. Furthermore, you would probably have better success if you would use manganese-copper in place of ferro-manganese. You could estimate the amount of manganese-copper necessary to introduce the proper quantity of manganese and the copper added with the latter would overcome any tendency towards brittleness. If you insist on using iron, would suggest that you add it in the form of ferro-zinc. It can be made by melting the zinc and adding the iron in the form of thin wire. It is not desirable to omit manganese if high tensile castings are to be made, but if aluminum brass will do your work you may leave out the manganese, but it will also be necessary to decrease the amount of zinc.

K. K.

TRADE PUBLICATIONS.

MELTING FURNACES.—The Rockwell Furnace Co., New York, has published a 32-page catalog describing its complete line of melting furnaces, designed for melting all metals, tinning, galvanizing, tool hardening, and all operations requiring molten metal or other heated baths. The furnaces described include the pit type crucible furnace, lift-out type crucible furnace, small crucible furnace for melting and assaying, a new tilting crucible furnace described in the September issue of THE FOUNDRY, single and double chamber simplex melting furnace, mint type crucible furnace, muffle furnaces, reverberatory scrap melting furnaces, reverberatory melting and cupelling furnaces, soft metal melting furnaces and sweep reducing furnaces. In addition, this concern manufactures galvanizing and tinning pots, metal heaters, oil burners, oil pumping systems, etc. These various furnaces are built for the use of coal, coke, oil and gas as fuel. The catalog is handsomely illustrated and well arranged.

SAW TABLE.—The E. Killing Molding Machine Works, Davenport, Iowa, in a four-page pamphlet describes the Black Hawk motor-driven universal saw table, which is adapted to a variety of work in sash and door factories, car shops, pattern shops, technical and manual training schools, etc. The table of this machine may be tilted at any angle up to 45 degrees.

RECORDING THERMOMETERS.—The Bristol Co., Waterbury, Conn., has just issued bulletins Nos. 91 and 93, which, together with bulletin No. 92, cover the line of Bristol recording thermometers for all ranges up to 800 degrees Fahr. Bulletin No. 91 is devoted to a description of recording thermometers for atmospheric temperatures and ranges to 250 degrees Fahr., and bulletin No. 93 is devoted to recording thermometers for working ranges from 40 to 800 degrees Fahr.

PHOSPHOR COPPER.—R. F. Lang, 34 Broadway, New York City, is mailing to the foundry trade an eight-page booklet describing phosphor copper. This alloy is intended for use as a copper deoxidizing agent. It is added in the crucible after the latter has been withdrawn from the furnace, and increases the temperature of the bath approximately 10 per cent. The metal should be well stirred to insure the proper distribution of the phosphorus throughout the bath. Manganese copper containing from 25 to 30 per cent of manganese is also described, as well as phosphor tin, which analyzes 95 per cent of pure Banca tin and 5 per cent of phosphorus.

BLACKSMITH TOOLS.—The Buffalo Forge Co., Buffalo, devotes catalog 78-A to a description of its complete line of blacksmith tools. This includes small hand blowers, tuyeres, portable forges of all kinds, stationary forges, etc. A complete line of drills, punches and shears is also described. The company's line of steel pressure blowers, electric forge blowers, planing mill exhausters, disc wheels and ventilators are also included.

PORTABLE HEATERS.—Portable heaters for heating work which is too bulky or inconvenient to remove to a furnace, and where it is desirable to take the heater to the work, such as annealing, hardening, expanding, bending, brazing, skin drying, lead melting, rivet heating, etc., are described in an eight-page catalog issued by the Rockwell Furnace Co., New York. The application of these heaters to various classes of work is described and illustrated. The heaters can be used to advantage in foundries for skin drying molds, especially for large floor work and cores, for heating and drying ladles, firing coke in small cupolas, melting soft metals, and for heating castings preparatory to burning in patches.

MOTORS.—Bulletin 159, published by the B. F. Sturtevant Co., Hyde Park, Mass., is devoted to a description of the Sturtevant type H motors, which are especially designed for direct connection to Sturtevant blowers and exhausters. They are made in 12 sizes, ranging from one to 100 horsepower and are built open, semi-enclosed or enclosed, according to the conditions of installation. Without destructive sparking or heating these motors will carry a 50 per cent overload for one hour, or 100 per cent overload for five minutes.

SOLID INGOTS AND CASTINGS.—Geo. G. Blackwell, Sons & Co., Ltd., Liverpool, England, have published a booklet devoted to a description of their various alloys. In one section the difficulties of iron founders are discussed and remedies are given for overcoming blow holes and other imperfections in malleable, gray iron, car wheel and chilled iron practice. This concern is offering to the trade a cupola flux designed to eliminate sulphur, remove other impurities, increase the fluidity of iron and it also preserves the cupola lining. It increases the strength of castings and improves low grade iron.

BASSITE.—The Bassite Mining & Smelting Co., Cincinnati, has issued a handsome 16-page booklet describing its alloy known as "Bassite," for brass foundry use. It is intended as a substitute for tin and was originally introduced to reduce the cost of production occasioned by the high price of tin, and is designed for consumption by manufacturers of general brass castings such as steam cocks, globe valves, plumbers' goods, builders' hardware, etc. It is likewise a valuable deoxidizing agent and permits the metal to be cast at a higher temperature than when alloyed with tin. Directions are also included for the use of this alloy and a number of valuable formulas are given.

GENERAL INDUSTRIAL NOTES

N. O. Fleming, 204 E. North avenue, Pittsburg, is in charge of the reorganization of the Union Foundry & Machine Co., Mansfield, O. This plant has been operated since 1872 and in addition to other departments, has a foundry covering about 40,000 square feet of floor space. The new company, in addition to carying on a jobbing business, will manufacture a full line of high pressure castings, grate bars, boiler castings, etc. Additional equipment will be purchased shortly and extensions are under consideration.

The new plant of the Pacific Malleable Castings Co., Riverside, Cal., is well under way. The main building will be 160 x 200 feet. Wm. F. Kerr is general manager.

The Heath Foundry & Mfg. Co., Plymouth. O., has been incorporated with a capital stock of $10,000 by Chas. E. Heath, C. F., John A., Percy H., and H. F. Root

The New Orleans Foundry & Iron Co., New Orleans, has purchased the plant of the Schwartz Foundry Co., of that city, at a cost of about $250,000. The officers of the new company are as follows: Louis Kohlmann, president; A. Katz, vice president; and Sigmund Kohlmann, secretary and treasurer. Extensive improvements are to be made, but these have not as yet been definitely decided upon.

The plant of the Central City Stove Co., Newark, O., will be removed to Anderson, Ind., and will be known as the Central Stove & Foundry Co.

The plant, equipment and stock of the Canadian Stove Co., Ottawa, Ont., was recently sold to Delahaye Bros., of Pembroke, Ont. The plant was originally known as the Ottawa Furnace & Foundry Co., and passed into the hands of the Canadian Stove Co. some time ago.

The Coatesville Foundry & Machine Co., Coatesville, Pa., has just completed the erection of its new foundry. The product will consist of boiler fronts and a general line of miscellaneous castings.

The John F. Byers Machine Co., Ravenna, O., has recently added a gray iron and brass foundry, as well as a fireproof pattern storage building.

The Bell City Steel Casting Co., Racine, Wis., has been incorporated with a capital of $4,000. The incorporators are: J. D. Dwight, M. J. Goepperil and W. C. McMahon.

The new plant of the Schaefer Co., Berlin, Wis., is rapidly nearing completion. It includes a large foundry, machine shop and power plant. This concern will engage in the manufacture of marine engines, and will do a general jobbing, foundry and machine shop business.

The Keeper Hunt Iron & Steel Co., Alexandria, Ind., is completing an addition to its foundry 60 x 250 feet.

The firm name of the Worcester Steel Foundry Co., manufacturer of crucible steel castings, has been changed to the Oakley Steel Foundry Co. This plant, which has been shut down for a considerable period, will immediately be placed in operation.

The Logansport Radiator Equipment Co., Logansport, Ind., has increased its capital stock from $50,000 to $75,000.

The Union Foundry Co., Anniston, Ala., manufacturer of cast iron soil pipe and fittings, has increased its capital stock from $100,000 to $200,000, and will make additions to its plant which will double its capacity.

The Bath Iron Works, Ltd., Bath, Me., ship builder and engineer, has been replacing the portion of its plant recently damaged by fire, employing its own force of men in this work, and reports satisfactory progress.

The Eagle Iron & Brass Foundry, Inc., Passaic, N. J., is at work on improvements which, when completed, will practically double its capacity, giving it a maximum melt of between 30 and 40 tons daily. The new foundry measures 85 x 130 feet and the machine shop about 35 x 100 feet. One of the old buildings at the plant has been replaced by a larger structure and the two cupolas now in operation are to give way to larger cupolas. W. M. Latham is president.

The International Engineering Co., Carter building, Scranton, Pa., will soon begin work on the construction of its large plant at Erie, Pa., and is already contracting for its equipment. In addition to extensive boiler and machine shops, a foundry 60 x 100 feet, carpenter and pattern shop 70 x 135 feet, and several smaller structures, will be erected. Tracks running into the plant from the Lake Shore & Michigan Southern and New York, Chicago & St. Louis railroads will provide excellent shipping facilities. The company was organized a few months ago for the manufacture of engines, boilers and general machine work.

The Lawrence Stove Co., Buffalo, N. Y., will replace the portion of its plant recently destroyed by fire with a three-story brick building at Seneca street and the Lehigh Valley railroad tracks.

The Wambold-Brunschweiler Co., which recently removed from Appleton, Wis., to Milwaukee, will erect a building 48 x 150 feet, for use as a brass foundry, office and finishing shop. The company has leased a building site at Thirtieth street and Lisbon avenue and will spend about $10,000 on its new plant.

Extensive improvements are contemplated by the Wisconsin Engine Co., Corliss, Wis. An addition will be erected to the foundry and new cottages will be put up for the employes, who will also have the privileges of a new club house.

The Dighton Foundry Co, Taunton, Mass., has been granted a charter to manufacture stoves. The capital stock of the company is $50,000, and the officers are: President, Herbert Q. Presbrey; treasurer and clerk, Fred P. Leonard; both of Taunton, Mass.

NEW CONSTRUCTION.

The Great Northern Smelting & Refining Co., Chicago, is erecting a new plant at Lowe avenue and Forty-first street, which will include a foundry 60 x 160 feet.

The Atlas Foundry Co., Marion, Ind., has been organized by M. J. Gartland, J. C. Haswell and J. H. Schaumleffel. The capital stock of the concern is $16,000 and a foundry will be built for the production of gray iron castings.

The Torrence Iron Co., Green Island, N. Y., is erecting a malleable plant, the main building of which is 75 x 400 feet. Rapid progress is being made on the buildings, and it is probable that the first heat will be run about Nov. 1.

The American District Steam Co., North Tonawanda, N. Y., has plans prepared for the reconstruction of its plant recently destroyed by fire. The following new buildings will be erected: Foundry, 100 x 120 feet, with two wings 40 x 50 and 36 x 118 feet, respectively; machine shop 50 x 261 feet, two stories high; dry kiln building, 36 x 150 feet, and the power plant will be remodeled.

The plant of the Albany Iron Works, Albany, Ore., which was destroyed by fire July 31, will shortly be rebuilt. In addition to machine and blacksmith shops, and a woodworking department, a foundry 36 x 55 feet will be built. This concern manufactures steam engines, mining and mill machinery.

John A. Selinger, Exchange building, Pottstown, Pa., is erecting a foundry at Bramcote, a suburb of Pottstown. Two cupolas will be installed, as well as a traveling crane.

The Link-Belt Co., Indianapolis, has purchased a tract of 20 acres about a mile south of its present plant, upon which a new malleable foundry will be built. Two buildings will be erected, each 800 feet long.

The Bollinger-Andrews Construction Co., 409-411 Empire building, Pittsburg, Pa., is erecting a new foundry at Verona, near Pittsburg. Pa., 130 x 320 feet, for the production of a line of heavy castings. The foundry equipment will consist of two 84-inch Whiting cupolas, a Whiting elevator, a No. 6 Piqua positive pressure blower, and three 20-ton electric cranes will serve the floors. A pattern shop 50 x 84 feet is also under construction, as well as several other buildings, including a power plant.

McClave & Bossart, Paxton, Ill., are fitting up a building for use as a foundry and machine shop. This concern will engage in the manufacture of iron, brass and aluminum castings.

The Salina Foundry & Mfg. Co., Salina, Kas., will erect a two-story building 52 x 112 feet.

The Globe Machinery & Supply Co., Des Moines, Iowa, will erect a new foundry 184 x 132 feet.

The Germantown Foundry & Machine Co., Germantown, Philadelphia, has commenced the erection of a new foundry for the production of light and medium castings. The officers of the new company are: Thomas Wye, president; John J. Welsh, vice president; Harvey M. Elliott, secretary and treasurer, and Adam Merget, general manager.

Announcement has been made that the plant of the Phoebus Foundry Co., Phoebus, Va., recently destroyed by fire will shortly be rebuilt.

The Washington State University, Seattle, Wash., will establish at that institution a fully equipped foundry.

A small brass foundry is being built at Columbiana, O., by William Lanten.

The Enterprise Foundry Co., Sackville, N. B., will rebuild its plant on the site of the one recently destroyed by fire. A model stove foundry will be erected, as well as a power house and a pattern storage building.

The Osborn Engineering Co., Cleveland, O., is completing plans for a five-story building 60 x 200 feet for the Cleveland Foundry Co., Platt avenue S. E. and the C. & P. tracks. The building will be of heavy mill construction.

The Marion Gray Iron Foundry, Marion, Ind., is considering extensions to its plant which will practically double its capacity.

The Sibley Machine Tool Co., South Bend, Ind., manufacturer of machine tools, is building a new foundry 88 x 154 feet, which will replace its present plant.